CAREER & TECHNOLOGY STUDIES

FABRICATION STUDIES

GUIDE TO STANDARDS AND IMPLEMENTATION

INTERIM 1995
(SEPTEMBER 1995 - SEPTEMBER 1997)

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MAY 1995

Alberta
EDUCATION

CURRICULUM STANDARDS BRANCH

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This document was prepared for:

Administrators	✓
Counsellors	✓
General Audience	
Parents	
Students	
Teachers	✓

Program/Level: Career and Technology Studies/Secondary

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NOTE: Shaded areas within this document have been approved for optional implementation. Assessment conditions and criteria are in draft form and will be validated 1994–97.

Questions or comments about this Guide to Standards and Implementation (Interim 1995) are welcome and should be directed to:

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CAREER AND TECHNOLOGY STUDIES

PROGRAM PHILOSOPHY/RATIONALE

Through Career and Technology Studies (CTS), secondary education in Alberta is responding to the many challenges of modern society, helping young people develop daily living skills, and nurturing a flexible, well-qualified work force.

In Canada's information society, characterized by rapid change in the social and economic environment, students must be confident in their ability to respond to change and successfully meet the challenges they face in their own personal and work lives. In particular, they must make decisions about what they will do when they finish high school. Many students will enter the work force, others will continue their education. All students face the challenges of growing independence and responsibility, and of entering the highly competitive workplace and/or post-secondary programs.

Secondary schools also face challenges. They must deliver, on a consistent basis, high quality, cost-effective programs that students, parents and community find credible and relevant.

CTS helps schools and students meet these challenges. Schools can respond more efficiently and effectively to student and community needs and expectations by using the opportunities in the CTS curriculum to design courses and access school, community and distance learning resources. Students can develop the confidence they need as they move into adult roles by assuming increased responsibility for their learning; cultivating their individual talents, interests and abilities; and defining and acting on their goals.

As an important component of basic education in Alberta secondary schools, CTS promotes students' achievement by setting clear expectations and recognizing students' success. Students in CTS develop competencies—that is, the knowledge, skills and attitudes students must demonstrate, or what they know and can do.

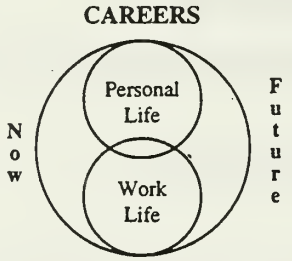
These competencies can be applied now and in the future as students make a smooth transition into adult roles in the family, community, workplace and/or further education. To help ensure this transition for students, clearly stated expectations and standards have been defined with the assistance of teachers, business and industry representatives and post-secondary educators.

CTS offers *all* students important learning opportunities. Regardless of the particular area of study chosen, students in CTS will:

- develop skills that they can apply in their daily lives now and in the future
- refine career-planning skills
- develop technology-related skills
- enhance employability skills

- apply and reinforce learnings developed in other subject areas.

In CTS, students build skills they can apply in their everyday lives. For example, in the CTS program, particularly at the introductory levels, students have the opportunity to improve their ability to make sound consumer decisions, and to appreciate environmental and safety precautions.

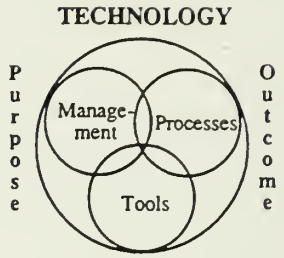


A career encompasses more than activities related to a person's job or occupation; it involves one's personal life in both local and global contexts; e.g., as a family member, a friend, a community volunteer, a citizen.

The integration of careers throughout the CTS program helps students make effective career decisions and target their efforts. Students in CTS will have the opportunity to expand their knowledge about careers, occupations and job opportunities and the education and/or training requirements involved. As well, they will recognize the need for lifelong learning.

Students in CTS will have the opportunity to use and apply technology and systems effectively and efficiently, which involves:

- a decision regarding which processes and procedures best suit the task at hand
- the appropriate selection and skilled use of the tools or resources that are available
- an assessment of and management of the impact the use of the technology may have on themselves, on others and on the environment.



Integrated throughout CTS are employability skills, those basic competencies that help students develop their personal management and social skills. Personal management skills are improved as students take increased responsibility for their learning, design innovative solutions to problems or challenges, and manage resources effectively and efficiently. Students' social skills improve through learning experiences that require them to work effectively with others, demonstrate teamwork and leadership, and maintain high standards in safety and accountability.

Further enhancing the employability skills, CTS reinforces and enhances learnings developed in core and other complementary courses. The curriculum emphasizes, as appropriate, the effective application of communication and numeracy skills.

Finally, in addition to the common outcomes described above, those students who focus on a particular area of study will develop career-specific competencies that support entry into the workplace and/or related post-secondary programs. Career-specific competencies can involve understanding and applying appropriate terminology, processes and technologies related to a specific career, occupation or job.

GENERAL LEARNER EXPECTATIONS

General learner expectations describe the basic competencies that are integrated throughout the CTS program.

Within an applied context that is relevant to personal goals, aptitudes and abilities, the student in Career and Technology Studies will:

- demonstrate the basic knowledge, skills and attitudes necessary for achievement and fulfillment in personal life
- develop an action plan that relates personal interests, abilities and aptitudes to career opportunities and requirements
- use technology effectively, linking and applying available tools, management and processes to produce a desired outcome
- develop personal management skills by:
  - linking theory and practice, using resources, tools, technology and processes responsibly and efficiently (managing learning)
  - applying effective and innovative decision-making and problem-solving strategies in the design, production, marketing and consumption of goods and services (being innovative)
  - selecting relevant, goal-related activities, ranking them in order of importance, allocating necessary time, and preparing and following schedules (managing resources)
- improve social interaction skills by:
  - demonstrating flexibility and cooperative work and communication behaviors (working with others)
  - participating as a team member by working cooperatively with others and contributing to the group with ideas, suggestions and effort (teamwork and leadership)
  - demonstrating high standards of diligence, attendance and punctuality, following safe procedures consistently, and recognizing and eliminating potential hazards (demonstrating responsibility)
- demonstrate appropriate verbal, written, composition, summarization and presentation skills
- use basic computation and measurement principles accurately and efficiently.

PROGRAM ORGANIZATION

CURRICULUM STRUCTURE

Career and Technology Studies is organized into *strands* and *modules.*

Strands in CTS define competencies that help students:

- build daily living skills
- investigate career options
- use technology (managing, processes, tools) effectively and efficiently
- prepare for entry into the workplace and/or related post-secondary programs.

In general, strands relate to selected industry sectors that offer positive occupational opportunities for students. Some occupational opportunities require further education after high school, and some allow direct entry into the workplace. The industry sectors encompass both goods-producing industries, such as agriculture, manufacturing and construction, and service-producing industries, such as business services, health services, and finance and insurance services.

Modules are the building blocks for each strand. They define what a student is expected to know and be able to do (exit-level *competencies*). Modules also specify prerequisites and facility and instructional parameters, where necessary.

The competencies a student must demonstrate to achieve success in a module are defined through the *module learner expectations.* Senior high school students who can demonstrate the module learner expectations (i.e., have the designated competencies) will qualify for one credit towards their high school diploma.

Module learner expectations are a culmination of the *specific learner expectations*, which provide a more detailed framework for instruction. They define the scope and depth of knowledge, skills and attitudes the student should acquire.

The following chart shows the 21 strands that comprise the CTS program and the number of modules available in each strand.

Strand	No. of Modules
1. Agriculture	31
2. Career Transitions	23
3. Communication Technology	32
4. *Community Health*	*25**
5. Construction Technologies	46
6. Cosmetology	58
7. Design Studies	31
8. *Electro-Technologies*	*33**
9. Energy and Mines	27
10. Enterprise and Innovation	8
11. Fabrication Studies	41
12. Fashion Studies	29
13. Financial Management	15
14. Foods	37
15. Forestry	21
16. Information Processing	43
17. Legal Studies	13
18. Management and Marketing	21
19. Mechanics	53
20. Tourism Studies	24
21. Wildlife	17

*Estimate

Note: *As of September 1995, 19 of the 21 strands are available for optional implementation in Alberta junior and high schools. The remaining strands, indicated above in italics, will be phased in from September 1995 to September 1996. Provincial implementation of all strands is scheduled for September 1997.*

LEVELS OF ACHIEVEMENT

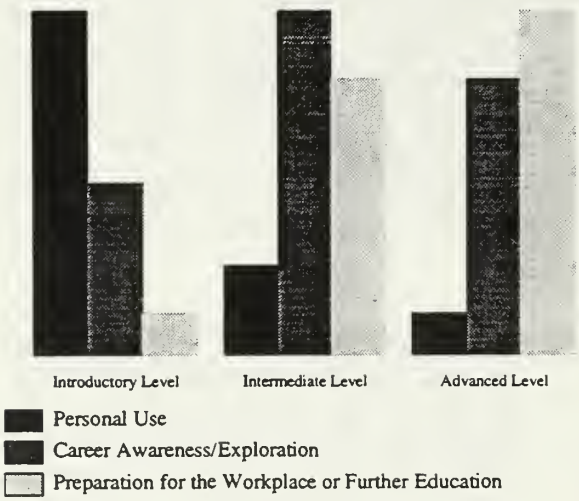
Modules are organized into three levels of achievement: introductory, intermediate and advanced. As students progress through the levels, they will be expected to meet higher standards and demonstrate increased degree of competence, both in the general learner expectations and the module learner expectations.

Introductory level modules help students build daily living skills and form the basis for further learning. Introductory modules are developed for students who have no previous experience in the strand.

Intermediate level modules build on the competencies developed at the introductory level. They provide a broader perspective, helping students recognize the wide range of related career opportunities available within the strand.

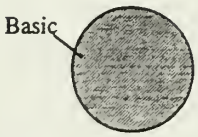
Advanced level modules demand a higher level of expertise and help prepare students for entry into the workplace or a related post-secondary program.

The following illustrates the relative emphasis on the aspects of career planning at each of the levels.



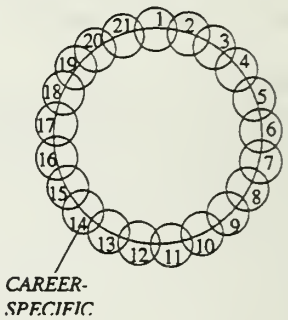
TYPES OF COMPETENCE

Two types of competence are defined within the CTS program: basic and career-specific.



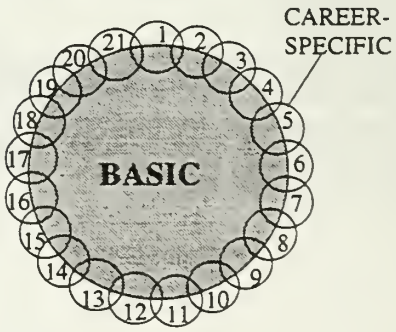
Basic Competencies are generic to any career area and are developed within each module. Basic competencies include:

- personal management; e.g., managing learning, being innovative, ethics, managing resources
- social; e.g., communication, teamwork, leadership and service, and demonstrating responsibility (safety and accountability).



Career-specific Competencies relate to a particular strand. These competencies build daily living skills at the introductory levels and support the smooth transition to the workplace and/or post-secondary programs at the intermediate and advanced levels.

The following model shows the relationship of these two types of competencies within the 21 strands of CTS (numbers refer to the chart on page A.5):



CURRICULUM AND ASSESSMENT STANDARDS

CURRICULUM STANDARDS

Curriculum standards in CTS define what students must know and be able do. Curriculum standards are expressed through general learner expectations for CTS, and through module and specific learner expectations for each strand.

ASSESSMENT STANDARDS

Assessment standards define how the student's performance will be judged. In CTS, each assessment standards defines the conditions and criteria to be used for assessing the competencies defined in each module learner expectation. Students must fully meet each assessment standard, including all of the criteria and conditions defined for the module. Assessment standards are in draft form, as are tools and weightings, and will be validated 1994–97.

Teachers throughout the province will be able to ensure students receive a fair and reliable assessment. Students will use the assessment standards to guide their efforts, ensuring they participate more effectively and successfully in the learning and assessment process. Standards at advanced levels are as much as possible linked to workplace and post-secondary entry-level requirements.

The following pages describe the Fabrication Studies strand in the Career and Technology Studies program.

FABRICATION STUDIES

STRAND RATIONALE

Metal products and structures have shaped world history. For thousands of years, metals have been shaped, joined and cast into items that have both utilitarian and artistic value. Even today, the search goes on to develop new metals, processes and products to take us into the 21st century.

The fabricated materials sector of the Canadian economy is characterized by a large number of small entrepreneurial businesses that supply the construction and manufacturing industries' intermediate or finished product requirements. This sector is a medium technology industry that depends principally on metals and related materials.

To compete in the North American and global markets, the fabricated materials sector is investing in leading-edge technology and is hiring highly trained and talented people to manage and operate this technology effectively and efficiently.

The Fabrication Studies strand has been developed within Career and Technology Studies (CTS) to help meet this educational need. Students selecting modules from the Fabrication Studies strand have the opportunity to investigate and develop important knowledge, skills and attitudes related to the properties of materials and the design and fabrication of useful products.

In this strand, students are provided with a broad base of relevant theory and practice that builds daily living and career-specific skills. Successful completion of advanced level modules gives students the skills and experience required for entry-level employment or for post-secondary education.

Within the philosophy of CTS, students in Fabrication Studies *will*:

- develop safe work and environmental practices
- develop self- and resource-management skills
- link the knowledge, skills and attitudes developed in other courses in meaningful and practical ways to the study of fabrication processes
- demonstrate flexibility, cooperative work behaviours, and effective communication and leadership skills
- link theory and practice using available resources, tools and materials responsibly and efficiently
- expand personal knowledge and appreciation of career options and training opportunities.

STRAND ORGANIZATION

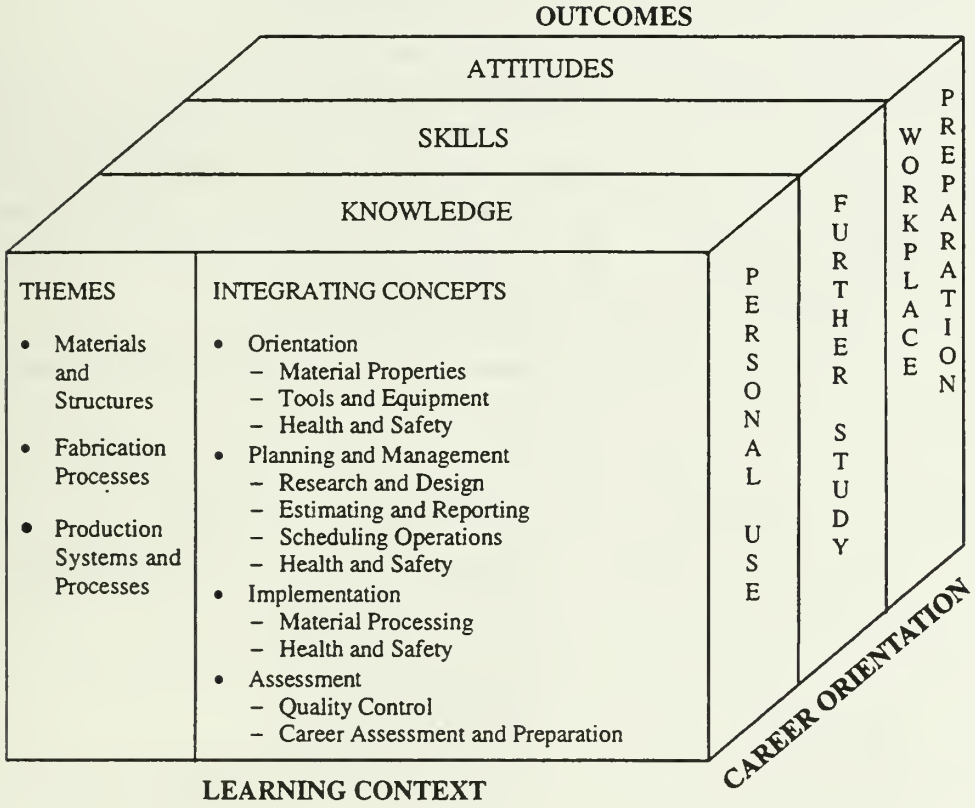
THEMES

The Fabrication Studies development model, shown below, has been developed around three themes that are central to the transformation of metals and like materials into useful artifacts and structures. These themes are:

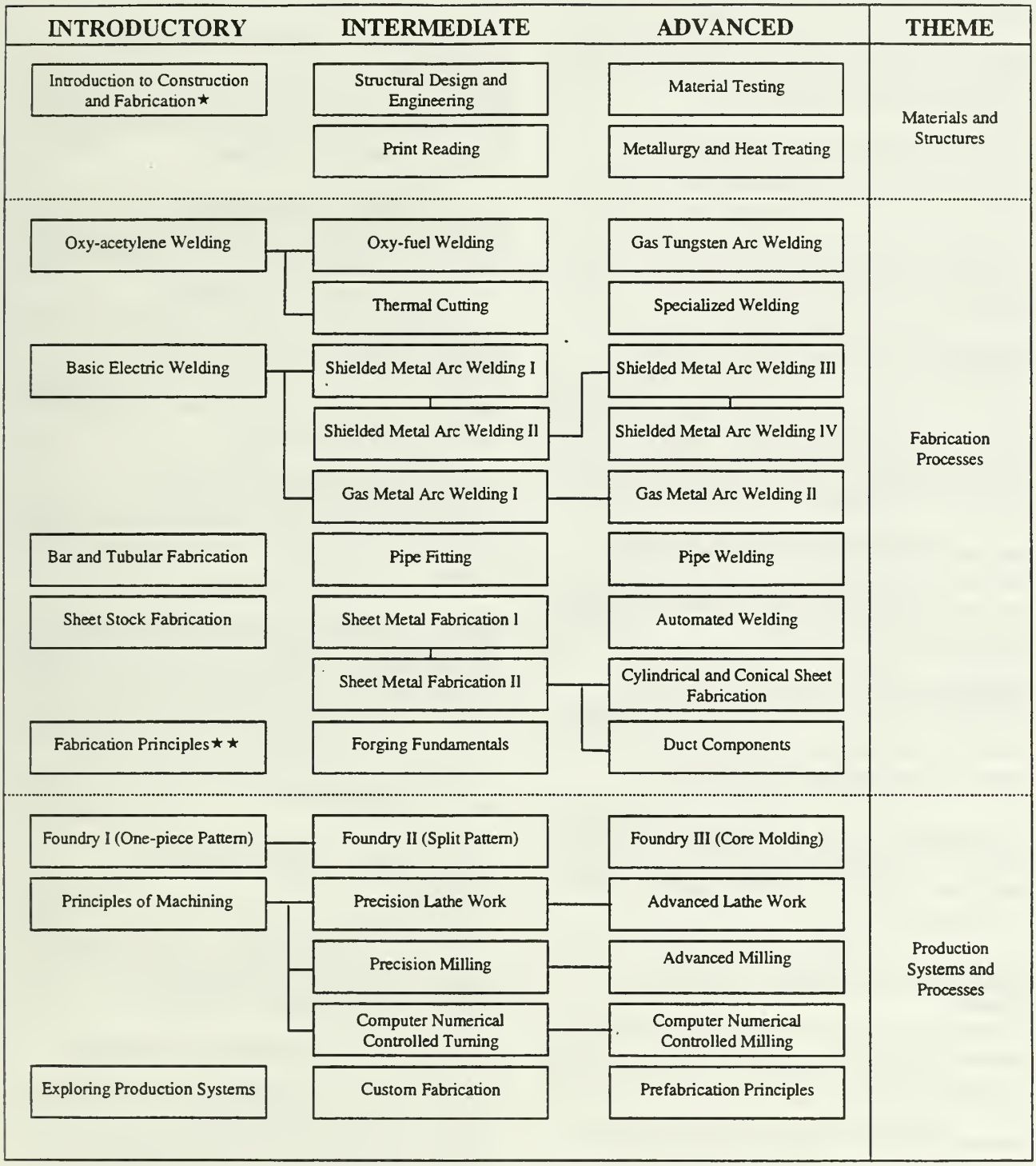
- Materials and Structures
- Fabrication Processes (cutting, bending, joining, finishing)
- Production Systems and Processes (casting, machining)

INTEGRATING CONCEPTS

Integrating concepts, shown on the face of the model, provide a basic framework for the study of each module. The context in which the learning takes place varies according available resources and the experience, background and intent of the learner. As the student is engaged in the learning activities in the school or in the community, specific outcomes are anticipated. These outcomes take the form of basic and career-specific knowledge, skills and attitudes that have been constructed by the learner.



SCOPE AND SEQUENCE — FABRICATION STUDIES



—— Prerequisite

★ Preprequisite to all modules in this strand. Module is also in Construction Technologies.
★★Recommended corequisite.

MODULE DESCRIPTIONS

Module CFS101: Introduction to Construction and Fabrication
Students develop basic tool and production skills to transform common building materials into useful products or structures. This module is prerequisite to all other modules in this strand.

Module FAB104: Oxy-Acetylene Welding
An oxy-acetylene system is one of the most versatile pieces of equipment for heating and welding. In this module, students develop basic skills in the safe handling and operation of oxy-acetylene supplies and equipment.

Module FAB105: Basic Electric Welding
Using electricity to provide energy for welding is an efficient and effective way of joining or building up metal surfaces. In this module, students develop basic skills related to the safe use and operation of one or more common electric welding systems.

Module FAB109: Sheet Stock Fabrication
Students use rudimentary tools, materials and processes to fabricate sheet materials into finished products, models or prototypes.

Module FAB110: Fabrication Principles
Students investigate and apply the fundamental principles of fabrication to build an artifact or structure from common structural materials.

Module FAB111: Bar and Tubular Fabrication
Students use cutting, bending and fastening processes to create a variety of products from bar and tubular stock.

Module FAB112: Foundry I (One-Piece Pattern)
Students develop the basic skills required to produce a simple one-piece pattern, sand mold and finished casting.

Module FAB113: Principles of Machining
Machining is one of the important ways to shape and finish a product. In this module, students develop basic metal hand and machine tool knowledge and skills to remove excess material by mechanical means.

Module FAB116: Exploring Production Systems
This module provides students with the opportunity to investigate and compare characteristics of a number of production systems.

Module FAB201: Structural Design and Engineering
Students investigate the nature of forces and structural materials and apply those findings to design and fabrication activities.

Module FAB202: Print Reading
Students develop basic skills in reading and interpreting working drawings to prepare a bill of materials and sequence of operations.

Module FAB203: Oxy-Fuel Welding
Students develop basic skills in the safe and efficient use of oxy-fuel equipment and supplies to braze weld and fusion weld.

Module FAB204: Thermal Cutting
Students develop basic skills in the safe and efficient use of thermal cutting equipment and supplies.

Module FAB205: Shielded Metal Arc Welding I
Shielded Metal Arc Welding (SMAW) is one of the most versatile forms of electric welding. In this module, students develop basic knowledge, skills and attitudes related to operation and use of SMAW equipment and accessories to make a variety of welds in the flat position.

Module FAB206: Shielded Metal Arc Welding II
This module provides students with the knowledge and skills to visually assess a weld and make the necessary adjustments to improve weld quality while building horizontal welding skills..

Module FAB207: Gas Metal Arc Welding I
Gas Metal Arc Welding (GMAW) skills are relatively simple to master, particularly in the flat position. This module provides the opportunity to build a knowledge and skill base related to this form of welding that has both personal use and commercial applications.

Module FAB209: Sheet Metal Fabrication I
Students use basic layout, cutting, bending and fastening operations to transform common types of sheet metal into consumer products.

Module FAB210: Sheet Metal Fabrication II
Students expand sheet metal skills in relation to pattern making, seam construction and edge treatment.

Module FAB211: Forging Fundamentals
Students determine the effects of heating and reshaping metal using forging techniques.

Module FAB212: Foundry II (Split Pattern)
Students extend pattern making and foundry skills to produce a split pattern mold and finished castings.

Module FAB213: Precision Lathe Work
Students develop basic turning skills used to size, shape and finish common machineable metals and plastics.

Module FAB214: Precision Milling
The milling machine and metal lathe are principal partners: what cannot be machined easily by one can often be done by the other. In this module, students develop basic milling skills to shape ferrous and non-ferrous materials.

Module FAB215: Computer Numerical Controlled (CNC)
Students develop skills in CAD and CNC programming to manufacture a product line on a CNC lathe.

Module FAB216: Custom Fabrication
Students work independently, or in a cooperative learning environment, to design, plan and construct a product/structure that meets specific client needs.

Module FAB217: Pipe Fitting
There are many domestic and industrial uses of pipes and pipelines. In this module, students learn basic piping principles, materials and fabrication skills.

Module FAB301: Material Testing
Students are introduced to the principles of materials testing, and to the development and evaluation of a mechanical materials test.

Module FAB302: Metallurgy and Heat Treating
The principles of metallurgy can be applied to all aspects of fabrication. In this module, students develop fundamental understandings and skills related to metallurgy and apply these to fabrication processes.

Module FAB303: Gas Tungsten Arc Welding
Students develop basic knowledge, skills and attitudes related to the application of Gas Tungsten Arc Welding (GTAW) principles, equipment and supplies to weld mild steel in the flat horizontal positions.

Module FAB304: Specialized Welding
Students develop specific skills associated with the use of common welding techniques to join and repair metals other than low carbon steel.

Module FAB305: Shielded Metal Arc Welding III
This module explains the role codes and standards have in the welding trade as well as providing the opportunity for students to test welds and build vertical welding skills.

Module FAB306: Shielded Metal Arc Welding IV
Students apply and extend positional welding skills using a variety of common electrodes

Module FAB307: Pipe Welding
Students develop specific skills related to pipe layout and preparation of pipe/tube joints and welding techniques.

Module FAB308: Automated Welding
Students investigate various machine and automated welding processes and systems

Module FAB309: Cylindrical and Conical Sheet Fabricating
Students develop specialized skills in pattern development and seam construction related to the use of ferrous and non-ferrous metals.

Module FAB311: Duct Components
Students apply and develop specialized skills in duct component pattern making and construction techniques.

Module FAB312: Foundry III (Core Molding)
Students investigate and apply advanced foundry processes to produce a hollow casting using a sand mold and core.

Module FAB313: Advanced Lathe Work
Students develop specialized lathe skills in thread cutting and taper turning techniques

Module FAB314: Advanced Milling
Students develop specialized skills in using vertical and/or horizontal milling machines.

Module FAB315: Computer Numerical Controlled Milling
Students develop skills in CAD and CNC programming to manufacture a three-dimensional product.

Module FAB316: Prefabrication Principles
Students work in a cooperative learning environment to design and construct a prefabricated product/structure to meet the specific needs of a customer.

Module FAB317: Gas Metal Arc Welding II
Students develop specific skills to assess and improve the quality of Gas Metal Arc Welding (GMAW).

PLANNING FOR INSTRUCTION

CTS provides increased opportunity for junior and senior high schools to design courses based on the needs and interests of their students and the circumstances within the school and community. Some strands may be appropriately introduced at the junior high school level. Other strands are more appropriately introduced at the senior high school level or to Grade 9 students. Refer to page C.3 of this Guide for recommendations regarding the Fabrication Studies strand, or the *CTS Manual for Administrators, Counsellors and Teachers* for a summary of the recommended grade levels for each strand.

PLANNING FOR CTS

Defining Courses

Schools determine which strands and modules will be offered in a particular school, and will combine modules into courses.

Each module was designed for approximately 25 hours of instruction. However, this time frame is only a guideline to facilitate planning. The CTS curricula is competency based, and the student may take more or less time to gain the designated competencies within each module.

A course will usually consist of modules primarily from the same strand but, where appropriate, may include modules from two or more strands. Refer to the *CTS Manual for Administrators, Counsellors and Teachers* for more information on course names and course codes.

Module selection and sequencing must consider the module parameters, which define:

- prerequisite and corequisites (entry-level competencies)
- instructional qualifications, if specialized
- equipment and facility requirements, if specialized.

The module parameters are defined for each module, in Sections D, E and F of this Guide.

Degree of Flexibility

The CTS program, while designed using the modular structure to facilitate flexible timetabling and instructional delivery, does not mandate the degree of flexibility a school or teacher will offer. The teacher and school will determine the degree of flexibility available to the student. Within the instructional plan established by the school, the student may:

- be given the opportunity to progress at a rate that is personally challenging
- have increased opportunity to select modules that develop competencies he or she finds most relevant.

Integrating Basic Competencies

Basic competencies are integrated throughout the CTS program and within each module. Selected basic competencies are emphasized within a module, depending on the nature of the career-specific competencies defined for the module.

Refer to Section G (Assessment Tools) of this Guide for the description of student behaviours expected at each of the three developmental levels defined for the basic competencies.

Assessment of basic competencies could include input and reflection from the student, teacher, peers and workplace supervisors. Description of the observed behaviour could be provided through a competency profile for the module. Positive, ongoing interaction between the student and teacher will support motivation for student growth and improvement.

The basic competencies related to managing resources, teamwork, accountability and safety should be emphasized in Fabrication Studies

modules, particularly at the advanced level where career-specific skills are being refined.

Although no mark would be assigned to the student's performance in the designated basic competencies, a description of the level of performance should be included within the assessment of each module.

Assessing Student Achievement

Assessing the student's competency is a process of gathering information by way of observations of process, product and student interaction.

Where appropriate, assessment tools have been defined to assist the teacher and student in the assessment. Refer to Section G (Assessment Tools) of this Guide to Standards and Implementation for copies of the various tools (worksheets, checklists, sample questions, etc.).

The relative weighting, or emphasis, for each assessment standard has also been established. The weighting is a guideline to help teachers determine a percentage grade for students.

Recognizing Student Achievement

At the high school level, successful demonstration of the exit-level competencies in a module qualifies the student for one credit. Refer to Section A of this Guide for more detailed information about how curriculum and assessment standards are defined in CTS. Refer to the *CTS Manual for Administrators, Counsellors and Teachers* for more information on how student achievement can be recognized and reported at the school and provincial levels.

Resources

A comprehensive resource base, including print, software and audio-visual, has been identified to support the Fabrication Studies strand. It is intended that these resources will form the basis of a resource centre, encouraging teachers and students to access a wide selection of resources and other information sources throughout the learning process. Unless otherwise noted, these resources are considered to be suitable for both junior and senior high school students.

Authorized resources may be obtained from the Learning Resources Distributing Centre or directly from the publisher or distributor. Refer to the Learning Resources section of this Guide for the complete resource list including curriculum correlations and resource annotations. Additional sources refer to non-commercial or government agencies that offer resources that may be of assistance in this strand.

In addition to the resources, sample Student Learning Guides are available. These samples, designed for individual student or small group use, provide an instructional plan for selected modules and include the following components:

- Why take this module?
- What are the entry-level competencies?
- What are the exit-level competencies?
- What resources may be accessed?
- What assignments/activities must be completed?
- What are the timelines?
- How will the final mark be calculated?

Sample Student Learning Guides have been developed for the following modules in Fabrication Studies.

- Introduction to Construction and Fabrication (CFS101)
- Structural Design and Engineering (FAB201)
- Material Testing (FAB301)
- Prefabrication Principles (FAB316).

Copies of these sample learning guides can be obtained, by request, from the CTS Unit in print and/or disk format (Microsoft Word).

PLANNING FOR FABRICATION STUDIES

The following suggestions are provided to assist teachers, school and school system administrators as they plan to deliver modules from the Fabrication Studies strand.

Selecting Modules

The scope and sequence chart on page B.5 provides an overview of the Fabrication Studies modules, indicating prerequisites and theme areas. Brief descriptions of the modules are on pages B.6 and B.7.

Course planning should take into consideration module sequences that link with both physical and human resources present in the school and community.

Fabrication Studies for Junior High School Students

Most introductory level modules may be offered to junior high school students. Since resources and expertise will vary in each school and community, it is important to assess potential support networks before selecting specific modules and module sequences.

The number of modules will vary according to the time available throughout Grades 7, 8 and 9:

Time Available	Modules
25 hours	**Introduction to Fabrication and Construction**
50 hours	**Introduction to Fabrication and Construction** **Fabrication Principles**
75 – 100 hours	*add one or two of the following:* **Sheet Stock Fabrication** **Principles of Machining** **Bar and Tubular Fabrication** **Exploring Production Systems**

Where appropriate, junior high school students may also take intermediate level modules, particularly in the Materials and Structures theme.

Fabrication Studies for Senior High School Students

Depending on the interests and intent of the students, modules in Fabrication Studies may be clustered in a variety of ways. Students with a general interest in the strand may wish to sample modules from the various themes, while those with specific interests may focus on a cluster of modules related to welding, foundry or machining as outlined in the Scope and Sequence chart.

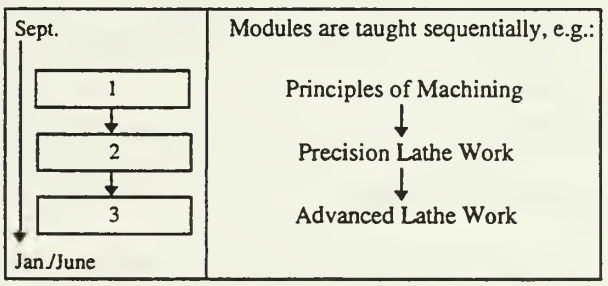
Students intending to continue their studies in a post-secondary institution and/or through apprenticeship should be aware of the post-secondary and apprenticeship linkages referred to in Section H. For example, basic to most trade-related programs is the need to have well-developed print reading and hand-tool skills. Such considerations will affect module selection.

Organizing for Learning

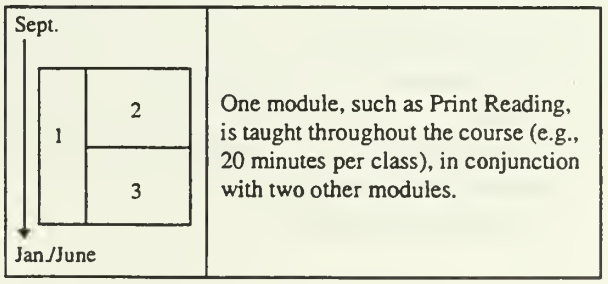
Before selecting modules, teachers should check the module parameters outlined in each module (see Sections D, E and F of this Guide). These module parameters describe prerequisite or corequisite modules and the recommended prerequisite or corequisite modules. Module parameters also indicate basic equipment and teacher expertise requirements.

Modules can be delivered sequentially, concurrently or combined as 3-, 5- or 6-credit courses as outlined below:

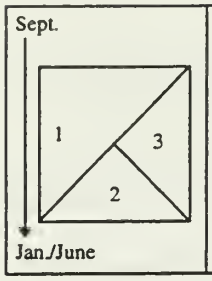
Scenario A



Scenario B


Sept.
1
2
3
Jan./June
One module, such as Print Reading, is taught throughout the course (e.g., 20 minutes per class), in conjunction with two other modules.

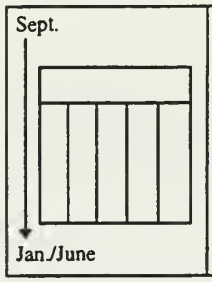
Scenario C



The time allocated to a corequisite module such as Fabrication Principles decreases as students develop these competencies.

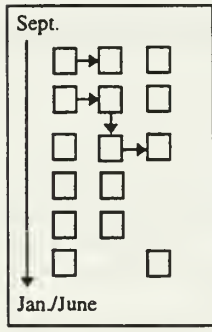
Teachers can also allow students to progress at a rate that is personally challenging.

Scenario D



All students take one or two modules together, such as Basic Electric Welding, and then take a series of Shielded Metal or Gas Metal Arc Welding modules.

Scenario E



Students select individual modules from a list of modules determined by the teacher. Then they establish time lines for the completion and submission of assignments, etc.

Identifying Linkages

Section H of this Guide describes some possible linkages between the Fabrication Studies strand and:

- other CTS strands
- complementary programs such as art and drama
- core programs, e.g., math, science, social studies and language arts
- off-campus programs.

Note that project modules from the Career Transitions strand may be combined with modules from the Fabrication Studies strand to provide increased opportunity for students to develop expertise and refine their competencies.

Project modules are **not** designed to be offered as distinct courses and should **not** be used to extend Work Experience 15, 25 and 35 courses.

Off-campus activities are recommended and should be an important part of teaching and learning throughout the Fabrication Studies strand. Safety must be a prime consideration in planning off-campus learning experiences. Adequate instruction, guidance and supervision should be provided at all times. Local, provincial and school policies must be understood and adhered to at all times.

Improving Smooth Transitions to the Workplace and/or Post-secondary Programs

As in other CTS strands, students will assess and prepare for future career opportunities. It is recommended that program planning include the integration of relevant career information and experiences. Through the development of career-specific skills, occupational profiles and on-site activities, students become aware of the training requirements and career opportunities related to the Fabrication sector of the economy.

Refer to Section H of this Guide for potential transitions students may make into:

- the workplace
- related post-secondary programs or other avenues for further learning.

MODULE CURRICULUM AND ASSESSMENT STANDARDS:

INTRODUCTORY LEVEL

The following pages define the curriculum and assessment standards for the introductory level of Fabrication Studies.

Introductory level modules help students build daily living skills and form the basis for further learning. Introductory modules are developed for students who have no previous experience in the strand.

Module learner expectations define the competencies a student must demonstrate to achieve success in a module. Assessment standards define the conditions and criteria to be used for assessing the competencies defined in the module learner expectations. These assessment standards and the accompanying assessment tools are in draft form and will be validated from 1994 to 1996.

Specific learner expectations provide a detailed framework for instruction to help students build the competencies defined in the module learner expectations. Additional information and suggestions for instruction are provided in the Notes column; teachers may wish to use this space to record their ideas for instruction or student projects.

Module CFS101:	Introduction to Construction and Fabrication	D.3
Module FAB104:	Oxy-Acetylene Welding	D.7
Module FAB105:	Basic Electric Welding	D.11
Module FAB109:	Sheet Stock Fabrication	D.15
Module FAB110:	Fabrication Principles	D.19
Module FAB111:	Bar and Tubular Fabrication	D.23
Module FAB112:	Foundry I (One-piece Pattern)	D.27
Module FAB113:	Principles of Machining	D.31
Module FAB116:	Exploring Production Systems	D.37

MODULE CFS101: INTRODUCTION TO CONSTRUCTION AND FABRICATION

Level: **Introductory**

Theme: **Materials and Structures**

Prerequisite: **None**

Module Parameters: **Materials work centre complete with basic hand tools**

Students develop basic tool and production skills to transform common building materials into useful products or structures. This module is prerequisite to all other modules in this strand.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student assessment will be based on:*	
• describe the operation of a technological system	• report on the operation of a technological system using a multimedia approach by: – identifying the parts of a technological system – describing each component – explaining the difference between an open and closed system. *Assessment Tool* *Framework for Reporting (No. 2.1)* *Standard* *A rating of 2*	10
• compare the properties of common constructional materials	• accurate identification and description of at least two different earth, plastic, metal, wood and composite materials. *Assessment Tool* *Matching Test* *Standard* *7 out of 10*	15
• identify and describe the safe use of basic hand tools	• given 10 basic hand tools, identification and description of their intended use. *Assessment Tool* *Matching Test* *Standard* *7 out of 10*	15

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student assessment will be based on:*	
• apply the use of a technological system to construct a product	• show how input, process, output and feedback mechanisms are involved in the production of a simple product. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Performance rating of 2*	60
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Technological Systems	• identify the parts of a technological system: – input – process – output – feedback	Use examples from construction and fabrication to show how input, process, output and feedback mechanisms are used to produce a product.

Concept	Specific Learner Expectations	Notes
	The student should: • list and describe the resource inputs that are required to make a technological system work; e.g., – people – information – materials – tools and equipment – energy – capital – time • describe the major stages in building a product; e.g., – designing – building – assembling – finishing	
• Social and Environmental Impacts	• evaluate the short- and long-term impact the products from industry may have on society and the environment • identify procedures that are used to provide feedback to evaluate a production system and its products	Consider the issues of recycling and disposal of used products at this point.
• Materials	• examine and perform experiments to explore the properties of a variety of common building materials • identify the different sizes, shapes and forms in which materials are commonly sold and distributed • identify proper handling and storing methods	Identify simple tests that will determine mechanical, electrical, magnetic, thermal and optical properties.
• Tools and Equipment	• identify common hand and power tools that are used to measure and mark, cut and shape, fasten and hold, mix and form, and coat and finish building materials	

Concept	Specific Learner Expectations	Notes
	The student should:	
• Health and Safety	• describe how tools are safely: – handled and stored – energized – used to process materials	Introduce hand and power-assisted tools as the students require them in their work.
	• review a safety plan in case of accident	
• Design	• identify the factors that affect the design of a product, e.g., safety, function, aesthetics, static and dynamic forces	
	• identify design techniques that are used to counteract static and dynamic forces.	Investigate the use of braces, trusses and ties.
Planning and Management		
• Product Selection	• choose a number of simple products that can be constructed or fabricated from common building materials	The intent of this module is to have the students explore the use of a variety of materials and tools to produce simple artifacts and structures.
	• locate or modify a set of plans and building procedures for each individual product	
	• identify appropriate materials and tools that are required to build, assemble and finish each product.	
Implementation		
• Material Processing	• use the identified materials, tools and process to: – build the parts of a product – assemble the parts – finish the product.	
Assessment		
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB104: OXY-ACETYLENE WELDING

Level: **Introductory**

Theme: **Fabrication Processes**

Prerequisite: **Introduction to Construction and Fabrication (CFS101)**

Module Parameters: **Access to oxy-acetylene welding equipment, fabrication facilities; instructor requires formal welding training and/or appropriate level of experience**

An oxy-acetylene system is one of the most versatile pieces of equipment for heating and welding. In this module, students develop basic skills in the safe handling and operation of oxy-acetylene supplies and equipment.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• recognize the hazards associated with oxy-acetylene welding and take preventive measures to avoid accidents and personal injury to self and others	• ongoing observed performance related to: – appropriate selection and use of personal protective equipment – maintenance of a clean and tidy work station – safe use of equipment and materials. *Assessment Tool* *Workplace Safety Assessment Profile (No. 4.1)* *Standard* *Performance rating of 2 on all points*	10
• perform safe start-up and shut-down procedures for an oxy-acetylene system	• demonstration of safe start-up and shut-down procedures, using Oxy-acetylene Welding (OAW) equipment. *Assessment Tool* *OAW Performance Checklist (No. 3.1)* *Standard* *All points to be completed satisfactorily*	20

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student assessment will be based on:*	
• demonstrate basic flat welding competencies	• completion of two fillet welds in the flat position using two different material thicknesses and filler rod diameters. *Assessment Tools* *Task Performance Appraisal (No. 1.1)* *Exemplar (No. 6.1)* *Standard* *Beads are to be slightly convex and of uniform width and height. Ripples are close, bullet shaped and free of voids, evidence of undercutting and overlapping* *Performance rating of 2*	70
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Oxy-acetylene Welding	• determine how oxygen and acetylene gases are produced, stored and transported • examine the construction of a oxygen and acetylene cylinder • explain the purpose and operation of a gas regulator and welding torch • associate the type of gas with the appropriate colour of hose, tank and threaded connection • determine how welding tips are sized	Even though oxy-acetylene welding is not used extensively in industry, it is a good medium to teach basic welding principles and skills.

Concept	Specific Learner Expectations	Notes
	The student should:	
	• observe and describe the characteristics of: – an oxidizing flame – a carburizing flame – a neutral flame	Review the parts of a flame and demonstrate where the greatest amount of heat is produced.
• Weld Joints, Position and Types	• identify typical weld types; e.g., – fillet – groove – plug • identify typical weld positions; e.g., – flat – horizontal – vertical – overhead • list and describe the basic weld joints; e.g., – butt – lap – tee – corner – edge	
• Health and Safety	• know the hazards associated with oxy-acetylene welding in relation to: – use of personal protective equipment – use of flammable gases under pressure – the need to remove or protect all combustible materials around the welding area • be able to describe a plan of action in the event of an accident.	Explain the importance of **not** allowing a stream of pure oxygen to come in contact with oily or greasy materials.

Concept	Specific Learner Expectations	Notes
Planning and Management • Start-up and Shut-down Procedures	*The student should:* • describe and demonstrate the safe start-up and shut-down procedures for oxy-acetylene welding • prepare a selection of coupons for basic butt and lap joints • select the appropriate tip for a given application • identify appropriate gas pressure for proper flame control • locate the appropriate fire extinguisher in the event of a fire.	In this module, students are not expected to set up the welding equipment; however, they are expected to demonstrate safe start-up and shut-down procedures.
Implementation • Fusion Welding	• demonstrate proficiency in: – puddling without using a filler rod – running lines of fusion with and without filler rod – welding fillet butt welds in the flat position.	Students should gain experience welding various thicknesses of materials using different diameters of filler rods and welding tip sizes.
Assessment • Quality Control • Career Preparation	• complete a visual inspection of a weld by considering the overall appearance, size and shape of the beads, plat penetration, fusion and degree of undercutting and overlapping • maintain a record of completed activities within a portfolio.	Have students identify the defects in unacceptable welds and suggest ways to overcome these imperfections.

MODULE FAB105: BASIC ELECTRIC WELDING

Level: **Introductory**

Theme: **Fabrication Processes**

Prerequisite: **Introduction to Construction and Fabrication (CFS101)**

Module Parameters: **Access to electric welding equipment and fabrication facilities; instructor requires formal welding training and/or appropriate level of experience**

Using electricity to provide energy for welding is an efficient and effective way of joining or building up metal surfaces. In this module, students develop basic skills related to the safe use and operation of one or more common electric welding systems.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• recognize the safety hazards associated with electric welding processes and take the necessary preventive measures to avoid accidents and personal injury	• observed performance in a typical work setting, related to: – appropriate selection and use of personal protective equipment – maintenance of a clean and tidy work station – safe use of equipment and materials. *Assessment Tool* *Workplace Safety Assessment Profile (No. 4.1)* *Standard* *Rating of 2 on all points*	10
• perform safe start-up and shut-down procedures for a gas metal and/or shielded metal arc welding processes	• demonstration of consistent safe start-up and shut-down procedures using Shielded Metal Arc Welding (SMAW) and/or Gas Metal Arc Welding (GMAW) equipment. *Assessment Tool* *SMAW Performance Checklist (to be developed)* *GMAW Performance Checklist (to be developed)* *Standard* *All points to be completed satisfactorily*	20

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student assessment will be based on:*	
• demonstrate basic arc welding practices and skills	• performing stringer and weave beads and the completion of fillet welds in the flat position using SMAW and/or GMAW equipment. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Beads should be slightly convex, free of voids and high spots. Ripples should be evenly spaced and uniformly wide* *Performance rating of 2*	70
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Electric Welding	• identify and describe the common electric welding processes and approved abbreviations; e.g., – Gas Metal Arc Welding (GMAW) – Gas Tungsten Arc Welding (GTAW) – Shielded Metal Arc Welding (SMAW) – Flux Cored Arc Welding (FCAW)	Students should realize that GMAW and FCAW processes are gaining in importance over other forms of welding.
	• describe how an arc is produced and controlled in: – gas metal arc welding and/or shielded metal arc welding	Discuss the need for the correct arc length, current, travel speed and electrode angle.

Concept	Specific Learner Expectations	Notes
	The student should:	
	• explain the purpose of the electrode coating and/or shielding gas in their respective processes	Have the students understand the need to protect the weld from atmospheric contamination.
	• identify the essential components and accessories used in gas metal and/or shielded metal arc welding	
• Weld Joints Position and Types	• identify typical weld types; e.g., – fillet – groove – spot – plug	
	• identify typical weld positions; e.g., – flat – horizontal – vertical – overhead	
	• list and describe the basic weld joint; e.g., – butt – lap – tee – corner – edge	
• Health and Safety	• know the hazards associated with gas metal and shielded metal arc welding	Students should be able to describe a plan of action in the event of an accident.
	• observe and demonstrate how personal protective equipment is used to protect eyes, skin and respiratory system	
	• review a safety plan in case of accident	
• Fire Prevention	• understand the need to remove or protect all combustible materials in the welding area	
	• identify and locate the appropriate fire extinguisher and fire blanket.	

Concept	Specific Learner Expectations	Notes
	The student should:	
Planning and Management		
• Weld Specifications	• determine from a weld specification the: – type of equipment to be used – size and type of electrode/wire – weld settings – type of weld, joint and weld position	For students just beginning to arc weld E6013 and/or E7014 electrodes are recommended.
• Weld Preparation	• prepare weld surfaces by removing any: – oil and/or grease – paint, rust or scale • review the start-up and shut-down procedures for a given piece of equipment • locate all pertinent safety equipment and clamping apparatus.	
Implementation		
• Electric Welding	• develop basic skills in: – selecting equipment and accessories – setting machine parameters – connecting work leads – striking an arc – running a stringer and weave bead – performing fillet welds in the flat positions using SMAW, GMAW and FCAW processes.	It is understood that students will require practice time to develop their skills using coupons and scrap material. However, as much as is possible, students should be allowed to develop these skills by fabricating simple products.
Assessment		
• Quality Control	• complete a visual inspection of a weld by considering the overall appearance, size and shape of the bead	
• Career Information	• investigate and describe examples of personal and trade-specific application of electric welding	
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB109: SHEET STOCK FABRICATION

Level: **Introductory**

Theme: **Fabrication Process**

Prerequisite: **Introduction to Construction and Fabrication (CFS101)**

Module Parameters: **Access to basic cutting, forming and fastening tools; instructor requires rudimentary knowledge of sheet fabrication processes**

Students use rudimentary tools, materials and processes to fabricate sheet materials into finished products, models or prototypes.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify and describe basic tools and processes used to fabricate sheet stock	• accurate identification and description of _____ tools and related processes. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	10
• demonstrate basic measurement and lay-out competencies	• application of measurement and layout techniques to create a pattern or template that is within the stated tolerances.	30
• perform basic sheet stock fabrication skills and practices	• successful completion of a sheet stock product that utilizes appropriate separating, combining and forming techniques. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *The product should be structurally sound, free of surface defects and conform to the overall size and shape requirements* *Performance rating of 2*	60

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – being innovative – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Sheet and Board Stock	• identify the common types and sources of sheet and board stock; e.g., – card stock – sheet metal – acrylic plastic – corrugated card and plastic – foam board – styrofoam	By working with a variety of sheet materials, students can better understand their working characteristics.
• Layout and Marking Processes	• identify and demonstrate the appropriate transfer and marking processes for a variety of sheet and board materials	
• Cutting Sheet Stock	• describe the process of separating sheet stock by: – shearing – scoring and snapping – sawing – hot wire cutting	
• Bending and Forming	• describe the process of forming sheet stock using a: – strip heater – break – vacuum former	

Concept	Specific Learner Expectations	Notes
• Combining Sheet Stock	*The student should:* • investigate typical joining and fastening techniques related to the use of: – mechanical joints and fasteners – adhesive – cohesives.	
Planning and Management • Operation Sequencing	• prepare a pattern or template to transfer cutting, folding and cutting lines • create a systematic sequence of operations to fabricate a product.	
Implementation • Material Processing and Fabrication	• develop basic skills related to the use of: layout and marking tools – cutting tools – forming tools – bonding materials – fastening devices	Consider the use of sheet stock to make models of products
• Finishing	• apply suitable finishes and surface details to a model, prototype or product.	
Assessment • Quality Control	• inspect a product for the overall attention to: – workmanship – accuracy – structural soundness – quality of finish	
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB110: FABRICATION PRINCIPLES

Level: **Introductory**

Theme: **Fabrication Process**

Prerequisite: **Introduction to Construction and Fabrication (CFS101)**

Module Parameters: **Access to basic cutting form and fastening tools; instructor requires rudimentary knowledge of fabrication processes.**

Student investigate and apply the fundamental principles of fabrication to build an artifact or structure from common structural materials.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify and describe the basic principles of fabrication	• written or oral presentation that accurately describes principles of separating, forming and combining. *Assessment Tool* *Framework for Reporting (No. 2.1)* *Standard* *Performance rating of 2*	10
• distinguish the important differences and applications of permanent, semi-permanent and temporary fastening techniques	• the appropriate selection of joining techniques that take into consideration: – serviceability – strength – appearance – ease and cost of production. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	15

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student assessment will be based on:*	
• demonstrate basic fabrication competencies using simple hand and power tools	• the completion of a simple product that uses two or more cutting and joining techniques. *Assessment Tools* *Task Performance Appraisal (No. 1.1)* *Standard* *The product should meet or exceed an "acceptable" level of quality and be completed within the appropriate time and cost limitations* *Performance rating of 2*	75
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – being innovative – communication – demonstrating responsibility. *Assessment Tools* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Measuring and Layout	• identify and describe measurement and layout tools that can be used to: – measure and mark a straight line on a metal surface – make an angle of 45° and 90° – create arcs and circles – measure the inside and outside dimensions of round and square stock	This module covers many of the bench metal practices. It can be taught along with other Fabrication Studies modules.

Concept	Specific Learner Expectations	Notes
	The student should:	
• Shaping Materials	• list and describe three distinct ways of changing the shape of a material; e.g., – separating – forming – combining	Use available equipment to illustrate these processes.
• Separating	• describe and give examples of tools that: – shear – chip – abrade	
	• identify other current and emerging processes that use: – heat – light – chemicals to shape a material	
• Forming	• outline principal methods of forming materials by: – bending or twisting – forging – casting	
• Combining	• list and describe common types of mechanical fasteners that are used with metal products	This is a good place to introduce students to soldering and resistance welding techniques; regular welding is covered in other introduction modules.
	• identify and describe typical bonding techniques that are used to combine metals; e.g., – soldering – welding – bonding	
	• determine when to use permanent semi-permanent and temporary fastening techniques	Threaded fasteners are a good example of temporary fasteners. Consider thread cutting using a tap and die set at this point.
• Conditioning	• explain why it may be necessary to change the physical state of some materials before they can be formed	

Concept	Specific Learner Expectations	Notes
• Finishing	*The student should:* • investigate processes that can be used to: – polish – coat – plate a surface to protect or improve the appearance of a product.	
Planning and Management • Health and Safety • Process Identification	• review principles of shop safety • review a safety plan in case of accident • for a given product design, determine the appropriate processes and tools to measure, layout, shape, condition and finish the materials • prepare a material list and sequence of events to fabricate a given product design.	Products to consider include: – key fob – pendant – trivet – paperweight – tray – box.
Implementation • Material processing	• develop basic skills related to separating, combining and forming processes.	
Assessment • Career Information • Career Preparation	• list and describe a variety of occupations and trades related to metal fabrication. • maintain a record of completed activities within a portfolio.	

MODULE FAB111: BAR AND TUBULAR FABRICATION

Level: **Introductory**

Theme: **Fabrication Processes**

Prerequisite: **Introduction to Construction and Fabrication (CFS101)**

Module Parameters: **Access to metal bending and fabricating equipment; instructor requires basic knowledge of fabrication processes**

Student use cutting, bending and fastening processes to create a variety of products from bar and tubular stock.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• list and describe common shapes and sizes of bar and tubular stock	• accurate identification and description of bar, angle and tubular forms. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	10
• demonstrate approved material handling and storage practices	• observed performance related to: – use of personal protective equipment – correct lifting techniques – proper storage of cut-offs. *Assessment Tool* *Material Handling and Storage Performance Checklist (No. 4.2)* *Standard* *(to be developed)*	20
• perform basic bar and tubular fabrication skills and practices	• successful completion of a bar and/or tubular product that uses one or more common metal forms. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *The product should be structurally sound, have tight-fitting joints and meet the stated size, shape and finish specifications* *Performance rating of 2*	70

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – being innovative – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Types of Bar and Tubular Stock	• identify common bar and tubular stock by size and shape	This module can be combined with other modules such as Fabrication Principles (FAB110), Forging Fundamentals (FAB211), and/or a welding module.
• Cutting	• describe typical methods of cutting bar and tubular stock to length • determine the most appropriate way to safely store and handle bar and tubular stock	
• Bending	• observe and note how to form: – eyes – circles – scrolls – square and zero bend radii using a metal bender • determine how to calculate the bend allowance for bar and tubular stock • determine when heat is required to bend a bar or tube	
• Fastening	• examine appropriate fastening techniques using: – mechanical fasteners – welding processes	

MODULE FAB111: BAR AND TUBULAR FABRICATION (continued)

Concept	Specific Learner Expectations	Notes
• Finishing	*The student should:* • determine how to pre-finish and finish a bar/tubular product to prevent corrosion and to improve appearance.	Have the students compare the quality of a spray coating to powder coating.
Planning and Management • Bend Allowance • Work Scheduling	• calculate the bend allowance for a given radius • create a material list and work schedule from a shop drawing.	
Implementation • Health and Safety • Material Processing	• demonstrate the safe use of hand and power assisted equipment • observe health and safety issues associated with the use of finishing materials • review a safety plan in case of accident • develop basic skills related to: – laying out and marking stock – cutting stock to length – bending arcs and angles – fastening components – finishing the product.	Projects suitable for this module include ornamental furniture, railing, gate and security bars.
Assessment • Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB112: FOUNDRY I (ONE-PIECE PATTERN)

Level: **Introductory**

Theme: **Production Systems and Processes**

Prerequisite: **Introduction to Construction and Fabrication (CFS101)**

Module Parameters: **Access to foundry supplies and equipment; instructor requires foundry training and experience**

Students develop the basic skills required to produce a simple one-piece pattern, sand mold and finished casting.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• recognize the hazards associated with casting metal and take preventive measures to avoid accidents and personal injury	• observed performance in a typical work setting, related to: – appropriate selection and use of personal protective equipment – maintenance of a clean and tidy work station – safe use of equipment and materials. *Assessment Tool* *Workplace Safety Assessment Profile (No. 4.1)* *Standard* *Performance rating of 2 on all points*	10
• demonstrate basic one-piece pattern mold making skills	• completion of a simple one-piece casting using foundry sand and a suitable foundry metal. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *The mold should have the appropriate gates, vents riser sprue and sand density* *The casting is to be clean and free of voids; removal and finish of the gates should not distract from the overall appearance of the product* *Performance rating of 2*	40

MODULE FAB112: FOUNDRY I (ONE-PIECE PATTERN) (continued)

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student assessment will be based on:*	
• demonstrate basic pattern making skills to make a one-piece mold	• completion of a simple one-piece pattern. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *The pattern should incorporate the appropriate fillets, sufficient draft to allow for easy extraction and allowance for shrinkage* *Performance rating of 2*	40
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation • Foundry Processes and Products	*The student should:* • list examples of everyday products that are made by casting • explain how a cast part differs from a forged part • list common metals used to make castings, e.g., – aluminium – brass – bronze – iron	Explain why aluminium is used for most school projects.

Concept	Specific Learner Expectations	Notes
	The student should: • describe the major casting processes; e.g., – sand casting – die casting – investment casting • identify and describe the parts of a sand mold • describe the advantages and disadvantages of a water-based sand and an oil-based sand • explain why a flux is used when a metal is melted • identify common tools and equipment used in sand casting	
• Mold Making	• observe and outline the basic procedures used to make a mold with a one-piece pattern	Explain the dangers of using a mold that has: • too much moisture content • improper vented and packed.
• Health and Safety	• describe the operation of a foundry furnace and safe methods of handling and pouring molten metal • list the types of personal protective equipment and the circumstances under which it should be worn • review a safety plan in case of accident	
• Pattern Making	• list and describe the types of patterns that are used to make sand molds • identify the types of materials that are suitable for making a pattern.	Demonstrate how a pattern is made and explain why it is important for a pattern to have the proper draft and shrinkage allowance.
Planning and Management • Casting	• determine the kind and amount of metal that is required for a given casting • determine the melting point and appropriate flux for a specified metal • evaluate the quality of sand and foundry metal	

MODULE FAB112: FOUNDRY I (ONE-PIECE PATTERN) (continued)

Concept	Specific Learner Expectations	Notes
• Pattern Making	*The student should:* • design or locate an article that can be cast using a one-piece pattern • select a suitable pattern making material.	
Implementation • Material Processing	• use the appropriate tools, materials and process to: – make a pattern – condition the sand – create a mold – heat and pour the molten metal – remove and finish the casting.	Students may need to be reminded **not** to overpack the mold.
Assessment • Quality Control • Career Preparation	• examine a completed casting and check to see that it is clean, free of voids and finished appropriately • maintain a record of completed activities within a portfolio.	

MODULE FAB113: PRINCIPLES OF MACHINING

Level: **Introductory**

Theme: **Production Systems And Processes**

Prerequisite: **Introduction to Construction and Fabrication (CFS101)**

Module Parameters **Access to a drillpress, bench or pedestal grinder and metal lathe; instructor requires machining skills and experience**

Machining is one of the important ways to shape and finish a product. In this module, students develop basic metal hand and machine tool knowledge and skills to remove excess material by mechanical means.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify and describe common machinable materials and machining processes	• accurate identification of three machinable materials and four common machining processes and related tools. *Assessment Tool* *(to be developed)*	15
• identify the hazards associated with machining tools and perform safe set-up procedures	• demonstrate safe set-up procedures using drilling, grinding and turning equipment. *Assessment Tool* *Drillpress Performance Checklist (to be developed)* *Bench/Pedestal Grinder Performance Checklist (to be developed)* *Metal Lathe Performance Checklist, Part A (to be developed)*	15

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student assessment will be based on:*	
• demonstrate basic hand and machine tool skills and practices	• application of machining principles to drill holes, remove excess material by grinding and face round and/or hexagonal stocks in a universal three-jaw chuck. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Dimensions are to be within stated tolerances and surfaces are to be flat and free of cuts and scratches* *Performance rating of 2*	70
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period emphasizing: – managing learning – managing resources – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Principles of Machining	• list and describe the principal methods of material removed by: – sawing – shaping – grinding – turning – milling – drilling – buffing • identify common machinable materials; e.g., – aluminium – mild steel – brass	Compare the principles of separating by chip removal and shearing

Concept	Specific Learner Expectations	Notes
	The student should:	
• Measurement	• describe the current systems of measurement used in machining and explain the advantages and disadvantages of each	
	• list and describe common types of: – rules – squares – dividers – callipers – micrometers – gauges that are used in connection with machining	Discuss the purpose of each of these tools and explain why it is important to take special care of these measuring devices.
• Machine Operations	• investigate methods of securing stock for purposes of machining; e.g., – chuck – vise – clamp	
	• examine common hand and machine tool processes of: – cutting and shaping – grinding and polishing – threading metal stock	
	• compare the operation of a manually operated machine to a computer controlled machine, related to: – accuracy – repeatability – reliability – productivity	Even if CNC equipment is not available, students should have a basic understanding of how this equipment operates.
• Drilling	• identify the major components and describe the operation of a drill press	
	• examine the design of a typical twist drill and methods of sizing	
	• explain how the proper drill speeds and feeds rate are determined	
	• describe purpose and list the types of lubrication that are used when drilling	
	• list and describe the safety hazards associated with drilling	

Concept	Specific Learner Expectations	Notes
	The student should:	
• Turning	• describe the major components and operation of a metal lathe • identify the appropriate cutting tool to face metal stock • explain what is meant by cutting speed, feed rate, depth of cut and how these variables are expressed and controlled • list and describe the safety hazards associated with turning	The emphasis in this module should be on facing and straight turning.
• Abrading	• identify the major components and operation of a bench or pedestal grinder • identify and describe different kinds of grinding wheels • explain why it is important not to overheat thin edges or points, nor to grind soft metals • identify the types and uses of cloth abrasives • list and describe the safety hazards associated with grinding.	Emphasize the importance of having the tool rest properly adjusted and proper wheel guards and eye shield in place. A wheel that has become cracked or loose should **never** be used.
Planning and Management • Product Design	• select or modify a product that incorporates: – drilling – grinding – turning operations • determine the machining operations and sequence them in a logical and efficient manner.	
Implementation • Machining Processes	• build basic skills in: – measurement and layout – drilling, grinding and turning operations to size, shape and finish a complete product.	

Concept	Specific Learner Expectations	Notes
Assessment	*The student should:*	
• Quality Control	• examine a completed product to determine whether it meets the specified tolerances and quality of finish	
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB116: EXPLORING PRODUCTION SYSTEMS

Level: **Introductory**

Theme: **Production Systems and Processes**

Prerequisite: **Introduction to Construction and Fabrication (CFS101)**

Module Parameters: **Access to materials work centre, complete with basic hand and power tools**

This module provides students with the opportunity to investigate and compare characteristics of a number of production systems.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• list and describe the common methods of manufacturing	• written or oral report that identifies and describes four different methods of manufacturing, such as custom, job-lot, continuous and just-in-time. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	15
• demonstrate basic production planning and managing skills	• collaboratively designed and developed production system that includes: – rationale for the type of system being used – production flow chart – resource and equipment requirements. *Assessment Tool* *Workplace Skills Assessment Framework (No. 4.1)* *Standard* *(to be developed)*	70
• identify the present and future career opportunities related to manufacturing	• presentation of a career profile that outlines: – present and future career opportunities – skill requirements – training opportunities. *Assessment Tool* *Occupation Profile Framework (No. 5.1)* *Standard* *(to be developed)*	15

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – communication – ethics – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation • Types of Manufacturing Systems	*The student should:* • list and describe the four basic types of manufacturing systems: – custom – job-lot – continuous – just-in-time	Explain how these manufacturing systems differ from each other.
• Health and Safety	• follow safety rules and guidelines associated with the task and working conditions • identify common hazards associated with the use of a specific tool, machining material or process • inspect for and correct potential hazards within the working environment • review a safety plan in case of accident.	

MODULE FAB116: EXPLORING PRODUCTION SYSTEMS (continued)

Concept	Specific Learner Expectations	Notes
Planning and Management	*The student should:*	
• Choosing a Manufacturing System	• choose a manufacturing system based on: – number of products to be produced – availability of resources – type of product – life cycle and durability of a product	Consider having students work together to produce a product(s) using one of the production systems outlined in this module.
• Product Design	• consider the following design standards when selecting product: – appeal – ease of manufacture – use of standardized parts – quality – cost	
• Production Engineering	• determine what tools, materials and processes will be required to manufacture the product • assist in the preparation of a flow chart that: – combines the worker, machines and materials in an organized unit – requires minimal movement of the worker and materials – identifies specific operations • make allowances for: – personal and environmental safety – easy access to utilities – ventilation – lighting – waste disposal – material and product handling	
• Production Tooling	• assist in the design of jigs, template and fixtures based on: – ease of use – ability to reduce error – cost and safety.	

Concept	Specific Learner Expectations	Notes
Implementation	*The student should:*	
• Production Work	• assist in the design, construction and operation of a production system.	
Assessment		
• Quality Control	• inspect the quality of the product by appearance and measurement to determine whether a product is at standard, needs reworking or should be rejected	Discuss the issue of quality control
• Career Information	• identify the career opportunities in the production field of manufacturing	
	• describe the impact of technology on the future of production careers	
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE CURRICULUM AND ASSESSMENT STANDARDS: INTERMEDIATE LEVEL

The following pages define the curriculum and assessment standards for the intermediate level of Fabrication Studies.

> Intermediate level modules help students build on the competencies developed at the introductory level and focus on developing more complex competencies. They provide a broader perspective, helping students recognize the wide range of related career opportunities available within the strand.

Module FAB201:	Structural Design and Engineering	E.3
Module FAB202:	Print Reading	E.7
Module FAB203:	Oxy-Fuel Welding	E.11
Module FAB204:	Thermal Cutting	E.15
Module FAB205:	Shielded Metal Arc Welding I	E.19
Module FAB206:	Shielded Metal Arc Welding II	E.23
Module FAB207:	Gas Metal Arc Welding I	E.27
Module FAB209:	Sheet Metal Fabrication I	E.31
Module FAB210:	Sheet Metal Fabrication II	E.35
Module FAB211:	Forging Fundamentals	E.39
Module FAB212:	Foundry II (Split Pattern)	E.43
Module FAB213:	Precision Lathe Work	E.47
Module FAB214:	Precision Milling	E.51
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Module FAB217:	Pipe Fitting	E.63

MODULE FAB201: STRUCTURAL DESIGN AND ENGINEERING

Level: **Intermediate**

Theme: **Materials and Structures**

Prerequisite: **Introduction to Construction and Fabrication (CFS101)**

Module Parameters: **Access to common hand and power-assisted tools; instructor requires basic understanding of structural design principles**

Students investigate the nature of forces and structural materials and apply those findings to design and fabrication activities.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• list and describe the principle characteristics of all structures	• a written or oral report that provides evidence that: – all structures found in nature or in the constructed world share common elements and principles – structural elements provide both shape and support to the structure – forces are dispersed throughout the structure – to keep a structure from failing, loads must be kept in balance *Assessment Tool* *Response Rating Scale (No. 2.2)* *Standard* *Response rating of 2*	20
• identify strategies to improve the efficiency of a structure	• complete analysis of a given structure to show how: – weight can be reduced – strength can be improved – utilization can be improved – building costs can be reduced *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	20

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student assessment will be based on:*	
• apply structural principles to design and building activities	• fabrication of a structure or components that meets the overall design criteria *Assessment Tool* *(to be developed)* *Standard* *Assessment will be based on the strength to weight ratio, cost of materials, appearance and ease of construction*	60
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – communication – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Characteristics of Structure	• through the analysis of natural and fabricated (synthetic) forms, determine that: – structural elements provide both shape and support – structures are built to withstand forces of nature, applied loads and the weights of the structural components – loads applied to a structure generate forces that must be kept in balance – most structures are built with a margin of safety	Compare the similarities of structure found in nature to those constructed by humans.

MODULE 201: STRUCTURAL DESIGN AND ENGINEERING (continued)

Concept	Specific Learner Expectations	Notes
	The student should:	
• Types of Structures	• identify from natural and synthetic structures examples of: – frame – shell – non-rigid structures	
• Structural Materials	• identify natural and synthetic structural materials that have good: – tensile strength – compressive strength – elasticity	Explain why it is important to understand the properties of a material before it is placed in a structure.
• Structural Elements	• list typical structural components that are used as: – linear elements; e.g., a beam – vertical elements; e.g., a column – non-rigid elements; e.g., a cable	
	• explain the purpose of rigid and non-rigid materials that are used between linear and vertical elements; e.g., plywood and canvas	
	• determine the advantages and disadvantages of non-rigid structures	
• Beam and Truss Construction	• show how triangulation is used to stabilize a truss and rectangular frame	
	• demonstrate the effects of moving a load close to or away from the neutral axis of a beam	
	• compare the connecting limits of adhesive and cohesive materials and rigid fasteners.	
Planning and Management		
• Structural Loading	• describe the effects of the following forces on a simple rigid structure: – compression – tension – shear – bending – twisting	

Concept	Specific Learner Expectations	Notes
• Design Application	*The student should:* • show how internal forces are created to balance external loads • demonstrate the effects one element has on another when it fails • critically analyze an existing structure and redesign it to increase its efficiency by: – reducing weight yet maintaining strength – enhancing its durability and usefulness – reducing material and construction costs.	
Implementation • Construction	• fabricate a structure or component using common materials, tools and contemporary design principles.	
Assessment • Quality Control and Efficiency	• analyze and test a structure or component to determine its: – strength to weight ration – cost – service and construction limitations	Simple testing devices can be constructed to determine the strength-to-weight ratio.
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB202: PRINT READING

Level: **Intermediate**

Theme: **Materials and Structures**

Prerequisite: **Introduction to Construction and Fabrication (CFS101)**

Module Parameters: **Appropriate print resources and print reading skills**

Students develop basic skills in reading and interpreting working drawings to prepare a bill of materials and sequence of operations.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify and describe the principal components of a print	• an oral or written response to questions regarding the use of lines, symbols, dimensions and notes on a working drawing. *Assessment Tool* *(to be developed)*	20
• demonstrate basic print reading skills	• preparation of a materials list and sequence of fabrication processes using a working drawing. *Assessment Tool* *(to be developed)* *Standard* *Types of materials, dimensions and tolerances should be stated accurately*	80
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – being innovative – communication – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

MODULE FAB202: PRINT READING (continued)

Concept	Specific Learner Expectations	Notes
	The student should:	
Orientation		
• Types of Drawings	• describe the types of drawings that are used to visualize an object pictorially and orthographically	This module can be taught independently or by integrating it with other modules in welding, sheet metal or machining.
• Lines	• identify and describe the types of lines commonly found on a drawing; e.g., – object – hidden – centre line – dimension	
• Dimensions	• examine dimensioning systems used to identify: – linear dimensions – angular dimensions – limits, fits and tolerance	
• Symbols	• identify the symbols used to describe: – types of materials – structural shapes – seams and joints – fabrication processes • read and interpret symbols denoting weld types and structural shapes	
• Fasteners	• identify the types of threaded fasteners and methods of representation; e.g., – detailed – schematic • identify the types of non-threaded fasteners and methods of representation; e.g., – detailed – symbols.	
Planning and Management	• explain how prints are used to create a: – bill of materials – cutting list – schedule of operations.	

MODULE FAB202: PRINT READING (continued)

Concept	Specific Learner Expectations	Notes
Implementation • Print Reading	*The student should:* • match pictorial and orthographic drawings that have: – surface parallel to the viewing places – hidden edges or surfaces – inclined and oblique surfaces – curved surfaces and holes • read and interpret multiview prints to determine object sizes, shapes and fabrication specifications • read and interpret the size, type and location of threaded and non-threaded fasteners • prepare a list of materials and sequence of machine/tool operations from a given print.	
Assessment • Quality Control • Career Preparation	• outline the importance of accurate prints and print reading skills to ensure high standards of quality and productivity • maintain a record of completed activities within a portfolio.	

MODULE FAB203: OXY-FUEL WELDING

Level: **Intermediate**

Theme: **Fabrication Processes**

Prerequisite: **Oxy-acetylene Welding (FAB104)**

Module Parameters: **Access to oxy-fuel welding equipment, supplies and facilities; instructor requires formal welding training and/or appropriate level of experience**

Students develop basic skills in the safe and efficient use of oxy-fuel equipment and supplies to braze weld and fusion weld.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will	*Assessment of student achievement will be based on:*	
• distinguish the important differences between braze welding and fusion welding	• an oral or written response that outlines the essential differences between braze welding and fusion welding. *Assessment Tool* *Response Rating Scale (No. 2.2)* *Standard* *Response rating of 3*	10
• demonstrate basic braze welding competencies	• completion of a braze weld application. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Performance rating of 2*	30
• demonstrate horizontal position and vertical position oxy-fuel welding competencies	• completion of fillet and square groove butt welds in the horizontal and vertical positions. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Beads are to be slightly convex and of uniform width and height; ripples are to be close, bullet shaped and free of voids, evidence of undercutting and overlapping* *Performance rating of 3*	60

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any Assessment Tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Health and Safety	• review health and safety issues such as: – use the appropriate personal protective equipment and clothing – keep the welding area free of combustible materials – insure adequate ventilation particularly when braze welding – returning and storing all consumables as directed – locating appropriate fire extinguishers in the event of a fire	
• Storage and Set-up of Oxygen and Fuel Cylinders	• describe the appropriate moving, storing and set-up procedures • identify local codes and restrictions related to the use and storage of oxygen and acetylene cylinders	Review WHMIS regulations regarding the safe storage and handling of oxy-fuel cylinders.
• Oxy-fuel Gases	• determine the alternate gases available for heating; their comparative temperatures and applications such as MAPP and propane	

MODULE FAB203: OXY-FUEL WELDING (continued)

Concept	Specific Learner Expectations	Notes
• Welding Principles	*The student should:* • formulate a working definition of fusion welding and braze welding • list the advantages and disadvantages of braze welding.	
Planning and Management	• select the correct filler rod and tip orifice for a given application • set working gas pressures to match the metal thickness, tip size and filler rod diameter • determine the appropriate clearance allowed between parts of a brazement.	Review safe start-up and shut-down procedures.
Implementation • Oxy-fuel Welding	• develop basic skills in braze welding in the flat position • develop basic fusion welding skills in the vertical and horizontal positions.	
Assessment • Quality Control • Career Information • Career Preparation	• complete a destructive and non-destructive weld assessment • investigate personal use and commercial applications of oxy-fuel welding • maintain a record of completed activities within a portfolio.	

MODULE FAB204: THERMAL CUTTING

Level: **Intermediate**

Theme: **Fabrication Processes**

Prerequisite: **Oxy-acetylene Welding (FAB104)**

Module Parameters: **Thermal cutting equipment and facilities; instructor requires formal welding training and/or appropriate level of training experience**

Students develop basic skills in the safe and efficient use of thermal cutting equipment and supplies.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify the hazards associated with thermal cutting and take preventive measures to avoid accidents and personal injury	• observed performance related to: – appropriate selection and use of personal protective equipment – safe use of equipment and supplies – measures taken to ensure work site safety. *Assessment Tool* *Workplace Safety Assessment Profile (No. 4.1)* *Standard* *Performance rating of 2 on all points*	10
• perform the safe start-up and shut-down procedures for oxy-fuel cutting and/or plasma arc system	• demonstration of consistent safe start-up and shut-down procedures using oxy-fuel and/or plasma arc equipment. *Assessment Tool* *Oxy-fuel Cutting Performance Checklist (to be developed)* *Plasma Arc Cutting Performance Checklist (to be developed)* *Standard* *All tasks performed correctly*	20

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student assessment will be based on:*	
• demonstrate basic manual cutting operations	• completion of uniform straight, irregular and bevel cuts as well as pierced holes. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Edges are to be square and drag lines are essentially vertical and not overly pronounced. There should not be evidence of gouging or excessive amounts of slag or dross* *Performance rating of 2*	70
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
	The student should:	
Orientation		
• Health and Safety	• identify the workplace labels and precautionary procedures when using: – compressed gas – flammable materials – oxidizing materials • review a safety plan in case of accident	

Concept	Specific Learner Expectations	Notes
	The student should:	
• Thermal Cutting Characteristics of Ferrous and Non-ferrous Metals	• determine common metals that can be successfully cut using: – oxy-fuel – air carbon arc – shielded metal arc – plasma arc processes	
• Oxy-fuel Cutting	• describe the oxy-fuel process in relation to: – ignition temperature and identification – slag and oxide removal	Explain why oxy-fuel cutting is limited to cutting ferrous materials.
	• identify the types of cutting fuels, their operating temperatures and efficiency ratios	
	• identify the parts of a cutting torch and their function	
	• describe the relationship between tip size, metal thickness and gas pressures	
	• determine the factors controlling tip selection; e.g., – depth of cut – type of material – condition of metal – type and quality of cut	
	• determine the correct way to start a cut and pierce a hole	
• Plasma Arc Cutting	• describe the plasma arc process in relation to: – arc formation – cutting gas – cooling – dross formation	Explain why the plasma arc process can be used for cutting both ferrous and non-ferrous materials.
	• identify and describe the purpose of the parts of a plasma arc cutting system	
	• describe the appropriate method to: – start an arc – control standoff distance – control the kerf	
	• list the advantages of using a plasma arc cutting system.	

Concept	Specific Learner Expectations	Notes
	The student should:	
Planning and Management		
• Tool Selection and Adjustment	• select and adjust the appropriate equipment for a given cutting operation	
	• review correct start-up and shut-down procedures	
	• clear the workplace of all combustible materials	
• Worker Safety	• locate the recommended fire extinguisher	
	• locate and wear the appropriate personal protective equipment.	
Implementation		
• Oxy-fuel	• demonstrate the use of oxy-fuel equipment to cut: – straight edges and bevels – curves – holes in mild steel plate	Besides preparing materials for fabrication, metal cutting equipment is often used to create metal sculpture.
• Plasma Arc	• demonstrate the use of plasma arc to cut: – straight and curved cuts – holes in ferrous and non-ferrous metals.	
Assessment		
• Quality Control	• perform a inspection of a cut and determine ways to improve the quality of the cut related to the size of the preheating flame, oxygen pressure, cutting speed and different machine settings, gas pressures and cutting speeds for plasma arc cutting	
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB205: SHIELDED METAL ARC WELDING I

Level: **Intermediate**

Theme: **Fabrication Processes**

Prerequisite: **Basic Electric Welding (FAB105)**

Module Parameters: **Shielded Metal Arc Welding equipment and facilities; instructor requires formal welding training and/or appropriate level of experience**

Shielded Metal Arc Welding (SMAW) is one of the most versatile forms of electric welding. In this module, students develop basic knowledge, skills and attitudes related to operation and use of SMAW equipment and accessories to make a variety of welds in the flat position.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify the appropriate treatment for minor injuries associated with welding processes	• the proper identification of first-aid treatment for minor cuts, burns and bruises *Assessment Tool* *First-Aid Test (to be developed* *Standard* *(to be developed)*	15
• describe the visual characteristics of a quality weld	• being able to list five attributes that describe visual characteristics of an arc weld that meets trade standards. *Assessment Tool* *Quality Descriptors (to be developed)* *Standard* *(to be developed)*	10

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate basic flat position shielded metal arc welding competencies	*Assessment of student assessment will be based on:* • the completion of a series of stringer and/or weave beads in the flat position on a given weldment and the completion of two successive – fillet welds using stringer and weave beads – square butt joints with a 2 mm (1/16") root opening. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Beads are to be slightly convex and of uniform width and height; ripples are to be close, bullet shaped and free of voids, slag inclusion, high spots and apparent restarts; plate surfaces and adjacent beads are penetrated and fused* *Performance rating of 3*	75
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation • First Aid	*The student will:* • demonstrate and describe the procedures for administering first aid for minor cuts, burns and bruises • explain the effects of arc flash and the suggested treatment • describe the effects of inadequate ventilation and the suggested treatment	Students need to have a good understanding of electrical terms and principles for their own safety and appreciation of how arc welding equipment operates.

Concept	Specific Learner Expectations	Notes
	The student will:	
• Electrical Fundamentals	• demonstrate knowledge of the following electrical terms: – direct current – alternating current – voltage – amperage – resistance – polarity	
• Arc Welding Equipment	• compare the operation and current output produced by a: – transformer – rectifier – generator	Explain the difference between a constant current power supply used in SMAW and a constant voltage supply used on GMAW.
	• explain the meaning of duty cycle	
• Welding Accessories	• describe the construction and sizing of cables	
	• compare the different types of electrode holders and maintenance requirements	
	• identify the types and uses of cable lugs, quick connectors and work clamps.	
Planning and Management		
• Technique	• describe and demonstrate the accepted methods of striking an arc	
	• describe the difference between a stringer bead and a weave bead	
	• describe and demonstrate the proper tacking procedures and weld profile for a flat fillet weld	
• Equipment Set-up	• adjust the equipment to coincide with the type of electrode, type of weld and metal thickness	Students should have experience using different electrodes and diameters: • E6011 (41011) • E6010 (41010) • E7018 (48018) • E7024 (48024).
• Weld Quality	• identify the attributes of a quality weld.	

Concept	Specific Learner Expectations	Notes
Implementation • Shielded Metal Arc Welding	*The student will:* • lay a consistent and even stringer bead and/or weave bead in the flat position • run a series of stringer beads in the flat position to create a padding • make lap and square butt welds on mild steel plate in the flat position.	
Assessment • Quality Control • Career Preparation	• complete a visual inspection of a weld by considering the overall appearance, size and shape of the beads; plate penetration, fusion and degree of undercutting and overlapping • maintain a record of completed activities within a portfolio.	

MODULE FAB206: SHIELDED METAL ARC WELDING II

Level: **Intermediate**

Theme: **Fabrication Processes**

Prerequisite: **Shielded Metal Arc Welding I (FAB205)**

Module Parameters: **Shielded Metal Arc Welding equipment supplies and facilities; instructor requires formal training and experience**

This module provides students with the knowledge and skills to visually assess a weld and make the necessary adjustments to improve weld quality while building horizontal welding skills.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• explain the current systems used to classify electrodes in Canada and the United States	• accurate identification of the characteristics of three different electrodes using the Canadian Standards Association (CSA) and the American Welding Society (AWS) codes. *Assessment Tool* *Exemplar, Electrode Coding (to be developed)* *Standard* *(to be developed)*	10
• identify strategies to assess and improve weld quality	• proper assessment of a weld given a cross-section and plan view and statement of measures to be used to correct observed faults. *Assessment Tool* *Exemplar, Reading Welds (to be developed)* *Standard* *(to be developed)*	15

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student assessment will be based on:*	
• demonstrate flat and horizontal position Shielded Metal Arc Welding competencies on mild steel plate	• completion of two successive single and multiple pass fillet welds in the horizontal position and a V-groove weld in the flat position. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Exemplar, Horizontal Fillet and Groove Welds (to be developed)* *Standard* *Welds are to be the correct width and height, free of voids, slag inclusion and apparent restarts, undercutting or overlapping; plate surfaces and adjacent beads have adequate penetration and fusion* *Performance rating of 3*	75
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
	The student should:	
Orientation		
• Mild Steel Electrodes	• describe the purpose of the core wire and electrode coating • identify the characteristics of an electrode using AWS and CSA codes • show the relationship between metal thickness, electrode size and welding amperage	Explain the importance of using the correct electrode for a given application and the difference between the way electrodes are classified in the AWS and CSA systems; e.g., a E-7018 is the same as a 48018 electrode.
• Arc Control	• compare straight and reverse polarity and the resultant heat distribution • discuss the advantages and disadvantages of using alternating and direct current • identify the cause and corrective measures for arc blow • describe the effects of a short and long arc on mild steel	
• Weld Assessment	• determine the effects of improper: – amperage setting – arc length – travel speed	Explain the conditions that produce undercutting, overlapping, incorrect bead formation and lack of penetration.
• Joint Preparation	• explain the importance of removing: – oil – paint – rust – mill scale from a joint before welding.	
Planning and Management		
• Electrode Selection	• determine the electrode(s) that can be used for a given application by considering: – properties of the base metal – weld position – flux requirements – material thickness.	

Concept	Specific Learner Expectations	Notes
Implementation	*The student should:*	
• Shielded Metal Arc Welding	• use the appropriate electrode and machine setting to make single and multiple pass fillet in the horizontal position and groove welds in the flat position.	
Assessment		
• Quality Control	• complete a visual inspection of a weld by considering the overall appearance, size and shape of the beads, plate penetration, fusing and degree of undercutting and overlapping	Have students understand that stray flash marks and excessive splatter also distract from the quality of the weld.
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB207: GAS METAL ARC WELDING I

Level: **Intermediate**

Theme: **Fabrication Processes**

Prerequisite: **Basic Electric Welding (FAB105)**

Module Parameters: **Gas Metal Arc Welding equipment, supplies and facilities; instructor requires formal welding training and/or appropriate level of experience**

Gas Metal Arc Welding (GMAW) skills are relatively simple to master, particularly in the flat position. This module provides the opportunity to build a knowledge and skill base related to this form of welding that has both personal use and commercial applications.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify the hazards associated with Gas Metal Arc Welding (GMAW) and take preventive measures to avoid accidents and personal injury	• observed performance related to: – appropriate selection and use of personal protective equipment – safe use of equipment and supplies – measures taken to ensure workplace safety. *Assessment Tool* *Workplace Safety Assessment Profile (No. 4.1)* *Standard* *Performance rating of 2 on all points*	10
• outline the advantages and disadvantages of GMAW over other forms of arc welding processes	• being able to list four advantages of GMAW over other forms of arc welding. *Assessment Tool* *Sample List (to be developed)* *Standard* *(to be developed)*	15

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate flat position and horizontal position GMAW competencies on light gauge mild steel	*Assessment of student assessment will be based on:* • completion of light gauge fillet and groove welds in the flat and horizontal positions. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Beads are to be slightly convex, and of uniform width and height; ripples are to be close, bullet shaped and free of voids, high spots and apparent restarts* *Performance rating of 3*	75
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation • Health and Safety	*The student should:* • review safety issues related to: – the appropriate use of personal and protective equipment – handling and storing consumables – keeping the welding area free of hazards – insuring adequate ventilation • review a safety plan in case of accident	

Concept	Specific Learner Expectations	Notes
• Gas Metal Arc Welding (GMAW)	*The student should:* • describe the basic components and operating principles of GMAW • identify the purpose and types of shielding gases • list and describe the methods of metal transfer in GMAW; i.e., – short arc – spray arc – globular • describe the wire types and methods of feeding in GMAW • identify and describe the different power supply used in GMAW • compare the advantage of GMAW over other arc welding processes.	Point out that the short arc process uses thinner wire, lower voltage and current than a spray arc process.
Planning and Management • Equipment Set-up	• select the appropriate type and size of wire, feed rate, current, flow rate and shielded gas for a given type of weld and/or weldment • selection of the appropriate flux cored wire and machine settings • prepare and clean all surfaces to be welded.	Explain why the filler wire should have the same properties as the base metal.
Implementation	• make light gauge fillet and groove welds in the flat and horizontal positions using GMAW and/or FCAW equipment.	
Assessment • Quality Control	• complete a visual inspection by considering the overall appearance, size and shape of beads, plate penetration, fusion and degree of undercutting and overlapping	

Concept	Specific Learner Expectations	Notes
• Career Preparation	*The student should:* • maintain a record of completed activities within a portfolio.	

MODULE FAB209: SHEET METAL FABRICATION I

Level: **Intermediate**

Theme: **Fabrication Processes**

Prerequisite: **Sheet Stock Fabrication (FAB109; recommended)**

Module Parameters: **Access to basic cutting, forming and fastening tools; instructor requires basic knowledge of sheet fabrication processes**

Students use basic layout, cutting, bending and fastening operations to transform common types of sheet metal into consumer products.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify and describe common types of sheet metal materials and tools	• accurate identification and description of five different sheet metal materials and 10 sheet metal machine tools. *Assessment Tool* *(to be developed)* *Standard* *Material description should state the properties, types of base metals and coatings and common usage*	20
• demonstrate approved material handling and storage practices	• observed performance related to: use of personal protective equipment – correct lifting techniques – measures taken to protect materials from surface damage – proper storage of cut-offs. *Assessment Tool* *Material Handing and Storage Checklist (No. 4.2)* *Standard* *(to be developed)*	10

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student assessment will be based on:*	
• perform basic sheet metal fabrication skills and practices	• successful completion of a given rectangular sheet metal product that uses one or more common seams and hems. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *The product should be structurally, free of surface defects and meet the stated size and shape specifications* *Performance rating of 3*	70
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Sheet Stock Identification and Handling	• identify common samples of sheet metal stock by their appearance and properties • determine the most appropriate way to safely handle and store metal stock • determine how sheet metal thicknesses are measured and stated	Point out that even though sheet metal work tends to be focused around a specific trade, the principles learned here have widespread applications.
• Cutting Sheet Stock	• explain the safe use of hand and machine tools to make internal and external: – straight cuts – curved cuts	

MODULE FAB209: SHEET METAL FABRICATION I (continued)

Concept	Specific Learner Expectations	Notes
	The student should:	
• Bending Sheet Stock	• explain the safe use of hand and machine tools to form a product	
• Seaming	• describe and give examples of uses for: – flange/butt – lap – folded – grooved seams	
• Riveting	• describe the advantages and disadvantages of: – tinner's rivets – pop rivets	
• Threaded Fasteners	• identify the common sizes and types of metal fastening screws and bolts	
• Soldering and Welding	• identify appropriate conditions and techniques to solder or weld a seam.	
Planning and Management		
• Pattern Layout	• calculate the appropriate hem and seam allowances for a given product	
• Operation Sequencing	• determine and mark the sequence and direction of all bends.	
Implementation		
• Material Processing and Fabrication	• build basic sheet metal process and fabrication skills related to: – layout – cutting – bending – fastening procedures.	

Concept	Specific Learner Expectations	Notes
Assessment	*The student should:*	
• Quality Control	• inspect a completed rectangular product for the overall attention to: – fit of seams – accuracy of measurement – structural soundness – quality of finish	
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB210: SHEET METAL FABRICATION II

Level: **Intermediate**

Theme: **Fabrication Processes**

Recommended Prerequisite **Sheet Metal Fabrication I (FAB209)**

Module Parameters: **Access to basic shearing, forming and fastening tools; instructor requires basic knowledge of sheet fabrication processes**

Students expand sheet metal skills in relation to pattern making, seam construction and edge treatment.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• describe and give examples of straight and parallel line developments	• correct description and identification of ___ examples of straight and parallel line developments. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	15
• demonstrate straight and parallel line developments and transfer skills	• use of approved practices to develop a straight line and/or parallel line development and transfer techniques to produce a product from light gauge sheet stock *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	25

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate proficiency in fabricating specific seams and edge treatments; e.g., – plain lap – single – grooved – Pittsburgh lock seams *and* – single hem – double hem – wired edge treatments	*Assessment of student assessment will be based on:* • the pattern being accurately laid out and within the stated tolerances. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *The product should be structurally sound and free of surface blemishes, seams and hems should be tight fitting and appropriate. All dimensions should meet design specifications* *Performance rating of 3*	60
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – being innovative – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation • Health and Safety	*The student should:* • review: – the use of appropriate personal protective equipment – proper storage of consumables • how to provide adequate air quality for welding, soldering and finishing • review a safety plan in case of accident	

Concept	Specific Learner Expectations	Notes
	The student should:	
• Pattern Development	• list and describe the following pattern developments: – straight line – parallel line – radial line – triangulations	Provide examples of products that are developed through straight, parallel radial line and triangulation.
• Pattern Types	• explain the use of: – full patterns – half patterns – pierced patterns	
• Hems and Edges	• identify and describe the purpose of a: – standing edge – single hem – double hem – wired edge • determine how to calculate the material allowance for a wire edge	
• Seams	• identify and describe the use of the following seams: – plan and counter lap – inside and outside lap – single and double seam – grooved – Pittsburgh lock	
• Shearing	• explain when to use: – combination, straight and aviation snips – notcher squaring shears	
• Soft Soldering	• describe how to forge and tin solder coppers • determine the appropriate flux for ferrous and non-ferrous applications • explain how to sweat solder lap, single- and double-seamed joints	

Concept	Specific Learner Expectations	Notes
• Other Fastening Techniques	*The student should:* • explain when it is appropriate to use: – spot welders – solid rivets – pop rivets.	
Planning and Management • Pattern Development	• calculate the material allowance for: – double and single seam – Pittsburgh lock • prepare a straight and/or parallel line development	Students without a background in drafting may require extra assistance to prepare a pattern.
• Operation Sequencing	• create a systematic sequence of operations to fabricate straight and/or parallel line product.	
Implementation • Material Processing and Fabrication	• build basic sheet metal process and fabrication skills related to specific seam and edge treatments and fastening techniques.	
Assessment • Quality Control	• establish a list of criteria to assess a sheet metal product and apply it to the evaluation of a completed product	Consider such factors as product design, usefulness, durability and overall workmanship.
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB211: FORGING FUNDAMENTALS

Level: **Intermediate**

Theme: **Fabrication Processes**

Prerequisites: **Bar and Tubular Fabrication (FAB111; recommended)**
Fabrication Principles (FAB110; recommended)

Module Parameters: **Access to heating equipment and forming tools; instructor requires forging knowledge and skills**

Students determine the effects of heating and reshaping metal using forging techniques.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify the hazards associated with metal forging and take preventive measures to avoid accidents and personal injury	• observed performance in a typical work setting, related to: – appropriate solution and use of personal protective equipment – safe use of a forge and forging tools – maintenance of a clean and tidy work station *Assessment Tool* *Workplace Safety Assessment Profile (No. 4.1)* *Standard* *Performance rating of 2 on all points*	10
• identify and describe the basic tools and processes used in forging	• accurate description of a forge and anvil; identification and description of drawing, tapering, bending, twisting and upsetting processes.	20
• demonstrate basic metal forging skills and practices	• application of forging principles to shape a machine tool or other product. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *The product is to be evenly shaped and finished; tempered and/or normalized according to the stated specifications* *Performance rating of 2*	70

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – being innovative – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Forging	• identify common and machine parts that are made by forging • compare the grain structure of a part shaped by forging with one shaped by casting or machining • identify and describe the types of hand tools that are used in forging	
• Hand Forging	• observe and note the use of: – hammers – tongs – sets – fullers – punches – swages • observe and note the processes of: – tapering – draw out – bending – twisting – upsetting	Hand forging is not widely practised in industry; however, the principles learned here are basic to all machine processes.

Concept	Specific Learner Expectations	Notes
	The student should:	
• Heating	• describe the parts of a coal or coke forge	
	• describe how this type of solid fuel forge is managed to heat effectively	
	• explain the chemical reactions between the heating elements and the work piece	
	• show how a combination of heating and quenching is used to control the shaping of the metal	
• Heat Treating	• describe the processes of hardening, tempering, annealing and normalizing related to forging	Heat treating concepts are further developed in the Metallurgy module (FAB302).
• Drop Forging	• compare the process of drop forging with that of conventional forging techniques.	
Planning and Management		
• Health and Safety	• identify the appropriate personal protective equipment used in forging	
	• review the approved start-up and shut-down procedures for a given forge	
• Operation Schedule	• create a sequence of forging operations by analyzing an existing forged part or shop drawing.	
Implementation	• develop basic forging skills using a variety of forging tools.	
Assessment		
• Career Information	• assess further local training and employment opportunities as a/an: – ornamental iron worker – farrier	
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB212: FOUNDRY II (SPLIT PATTERN)

Level: **Intermediate**

Theme: **Production Systems and Processes**

Prerequisite: **Foundry I (FAB112)**

Module Parameters: **Access to foundry supplies and equipment: instructor requires foundry training and experience**

Students extend pattern making and foundry skills to produce a split pattern mold and finished castings.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• describe the important similarities and differences between a one-piece pattern and a split pattern	• oral or written response that outlines the important similarities and differences between a one-piece pattern and mold and a split pattern and mold. *Assessment Tool* *Response Rating Scale (No. 2.2)* *Standard* *Response rating of 2*	10
• describe and perform safe start-up and shut-down procedures for the safe operation of a foundry furnace	• demonstration of safe start-up and shut-down procedures connected with melting and pouring metal. *Assessment Tool* *Foundry Performance Checklist (to be developed)* *Standard* *All tasks meet accepted practices*	15
• demonstrate basic pattern making skills used to make a split pattern	• successful completion of a simple split pattern mold. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *The pattern should have sufficient draft, shrinkage, allowance and alignment mechanism* *Performance rating of 3*	40

MODULE FAB212: FOUNDRY II (SPLIT PATTERN) (continued)

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• demonstrate split pattern making and casting competencies	• successful completion of a mold and casting using a split pattern. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *The mold should be appropriately vented gated and rammed. The casting should be clean and free of voids; removal of gates should not distract from the overall appearance of the product* *Performance rating of 3*	35
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Foundry Processes and Products	• from a selection of cast objects, list those made from two-part patterns and identify the "parting-line" on each casting	The same emphasis should be placed on pattern making as is placed on casting and finishing a product.

Concept	Specific Learner Expectations	Notes
	The student should:	
• Pattern Making	• describe the type of pattern used to make a mold for cylindrical/spherical objects	
	• explain how a split pattern is aligned and why this is necessary	
	• compare the shrinkage allowances for: – aluminium – brass – cast iron	
• Mold Making	• observe the correct use of foundry tools and equipment to make a mold from a two-part pattern	
	• explain how the two parts of the mold are aligned correctly	
• Foundry Furnaces	• list and describe common foundry furnaces and accessories	Demonstrate how to safely start up and shut down a foundry furnace.
	• identify safe start-up and shut-down procedures for a given furnace.	
Planning and Management		
• Heating and Pouring	• determine the correct pouring temperature for both aluminium alloy and lead-based alloys	
	• identify appropriate fluxes to be used with the melting process	
• Health and Safety	• identify the dangers relating to: – handling ceramic crucibles – moisture in contact with molten metal – metals splashing – molds incorrectly vented – danger of metal escape if mating flask surfaces are damaged – water as a sand binder – fumes from metal, fluxing and binders – common foundry practices to avoid injury in all of the above	
	• review a safety plan in case of accident.	

Concept	Specific Learner Expectations	Notes
Implementation • Material Processing	*The student should:* • use the appropriate tools, materials and processes to: – construct a split pattern – create a sand mold – pour – cool – remove flash, gates and runners – finish a sand casting.	
Assessment • Quality Control • Career Preparation	• identify the cause of porosity in a casting and take appropriate measures to correct the problem • maintain a record of completed activities within a portfolio.	

MODULE FAB213: PRECISION LATHE WORK

Level: **Intermediate**

Theme: **Production Systems and Processes**

Prerequisite: **Principles of Machining (FAB113)**

Module Parameters **Access to a metal lathe and ancillary equipment; instructor requires machining skills and experience**

Students develop basic turning skills used to size, shape and finish common machineable metals and plastics.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify the hazards specific to metal turning and take preventive measures to avoid accidents and personal injury	• observed performance related to: – appropriate selection and use of personal protective equipment – containment of long hair, loose clothing, removal of rings and other forms of jewellery – safe handling of materials – precautions taken to ensure the safety of others. *Assessment Tool* *Workplace Safety Assessment Profile (No. 4.1)* *Standard* *Performance rating of 2 on all points*	10
• perform safe metal lathe set-up procedures	• demonstration of approved practices to: – mount work in a three- or four-jaw chuck – mount work using a chuck and a live or dead centre – mount work between centres. *Assessment Tool* *Metal Lathe Performance Checklist, Part B (to be developed)* *Standard* *All tasks performed correctly*	15

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate basic straight turning and finishing skills	*Assessment of student assessment will be based on:* • completion of the following machining operations: – face stock in a three- or four-jaw chuck – drill centre holes – turn work in a three- or four-jaw chuck – turn work between centres – knurl and finish. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Dimensions and levels of finish are to be within stated tolerances and specifications* *Performance rating of 3*	
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Health and Safety	• observe all safety procedures related to the use and operation of metal turning equipment • identify and correct common hazards related to machine lathe and turning processes • review a safety plan in case of accident	Explain the operation of a metal lathe, identify accessories and point out how a lathe is sized by the length of its bed and swing.
• Machining Characteristics	• compare the machining characteristics of common ferrous and non-ferrous materials	

MODULE FAB213: PRECISION LATHE WORK (continued)

Concept	Specific Learner Expectations	Notes
	The student should:	
• Lathe Parts and Accessories	• identify and describe the basic parts and accessories of an engine lathe • explain the difference between a three- and a four-jaw chuck • identify cutting and forming tools that are used for: – roughing – facing – boring – parting – knurling – finishing	
• Machine Operations	• observe and record the correct procedures to: – mount work in a three- and/or four-jaw chuck – mount work between centres • examine set-up procedures to face, centre drill, straight turn and bore stock • determine the factors that affect spindle speed, feed rate and depth of cut • examine and describe safe finish techniques, using files and abrasives • identify and describe lathe and lathe tool lubricants and coolants.	Demonstrate how to centre an object in a four-jaw chuck and how to select and centre a cutting tool.
Planning and Management		
• Print Reading	• from a machine drawing of a turned part, identify: – overall dimension – types of material – types of finishes – fits and tolerances • list and describe the machining operations in a logical order • calculate the appropriate cutting speeds, feed rates and depth of cuts for rough turning, finishing, drilling and knurling.	

Concept	Specific Learner Expectations	Notes
Implementation • Lathe Work	*The student should:* • build basic turning skills related to: – facing – centre drilling – straight turning – drilling – boring common machineable metals and/or plastics.	Products such as a mallet and screwdriver handle provide students with a wide range of lathe experience.
Assessment • Quality Control • Career Preparation	• investigate ways to improve output quality and reduce machining time • maintain a record of completed activities within a portfolio.	

MODULE FAB214: PRECISION MILLING

Level: **Intermediate**

Theme: **Production Systems and Processes**

Prerequisite: **Principles of Machining I (FAB113)**

Module Parameters **Access to a vertical and/or horizontal mill and ancillary equipment; instructor requires machining skills and experience**

The milling machine and metal lathe are principal partners: what cannot be machined easily by one can often be done by the other. In this module, students develop basic milling skills to shape ferrous and non-ferrous materials.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify the hazards specific to milling operations and take preventive measures to avoid accidents and personal injury	• observed performance related to: – appropriate selection and use of personal protective equipment – containment of long hair, loose clothing, removal of rings and other forms of jewellery – safe handling of materials – keeping a clean and orderly work area. *Assessment Tool* *Workplace Safety Assessment Profile (No. 4.1)* *Standard* *Performance rating of 2 on all points*	10
• perform appropriate set-up and servicing procedures on a milling machine	• demonstration of approved practices related to the safe set-up of a vertical and/or horizontal mill. *Assessment Tool* *Milling Machine Performance Checklist, Part A (to be developed)* *Standard* *All tasks are performed correctly*	15

MODULE FAB214: PRECISION MILLING (continued)

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student assessment will be based on:*	
• demonstrate basic milling machine skills and practices	• completion of a milled part that incorporates square and bevelled surfaces using a vertical and/or horizontal mill. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Dimensions and quality of finish are to be within stated tolerances and specifications* *Performance rating of 2*	75
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
	The student should:	
Orientation		
• Health and Safety	• observe all safety procedures related to the use and operation of metal milling equipment • review a safety plan in case of accident	
• Mill Parts and Accessories	• identify and describe the basic parts and accessories of a milling machine • compare the operation and uses of a vertical mill to a horizontal mill	Describe the two basic types of milling machines and the types of surfaces and features they are able to produce.

Concept	Specific Learner Expectations	Notes
	The student should: • identify and describe the types of cutters used in vertical and horizontal milling according to their size, construction and purpose; e.g., – plain milling – side milling – end milling cutters	
• Lubricants and Cutting Fluids	• determine and use the recommended lubricants for a given milling machine • identify the purpose of a cutting fluid and identify common types	
• Machine Operation	• investigate typical set-up procedures for horizontal and/or vertical milling to create flat surfaces, grooves and chamfers • identify the factors that determine cutting speeds, feed rates and depths of cuts • explain the advantages and disadvantages of conventional and climb milling.	Do not attempt climb milling without backlash eliminators.
Planning and Management		
• Print Reading	• determine from a machine drawing of a milled part, the: – overall dimensions and tolerance – quality of surface finish – most appropriate milling machine and cutters to be used	
• Squaring Operations	• list and describe the machining operations to square stock, bevel and chamfer surfaces • calculate the appropriate cutting speeds, feed rates and depth of cuts for a specific operation.	
Implementation		
• Milling	• build basic competencies using a milling machine to rough size, square, bevel, chamfer and finish machine parts to the prescribed tolerances and specification.	The main emphasis should be on surface profiles.

Concept	Specific Learner Expectations	Notes
Assessment • Quality Control • Career Preparation	*The student should:* • investigate ways to improve output quality and machining time • maintain a record of completed activities within a portfolio.	

MODULE FAB215: COMPUTER NUMERICAL CONTROLLED (CNC) TURNING

Level: **Intermediate**

Theme: **Production Systems and Processes**

Prerequisite: **Principles of Machining (FAB113)**

Module Parameters: **Access to a CNC turning centre; instructor requires CAD and CNC programming and machining skills**

Students develop skills in CAD and CNC programming to manufacture a product on a CNC lathe.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify the safety hazards associated with a computer numerical controlled (CNC) lathe and take the necessary precautions to avoid damage to the equipment and personal injury	• ongoing observation related to: – appropriate selection and use of personal protective equipment – use of safety covers and guards – use of dry runs. *Assessment Tool* *Workplace Safety Assessment Profile (No. 4.1)* *Standard* *Performance rating of 2 on all points*	10
• demonstrate two dimensional programming and/or CAD skills	• development of a 2-D program to produce a machinable part on a CNC lathe using absolute coordinates and/or CAD file conversion *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	60
• operate a CNC lathe to manufacture a turned part	• performing the appropriate set-up testing and running procedures to produce a turned part. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	30

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Lathe Operation	• observe the operation of a CNC lathe and determine how turning speeds, feed and feed rates are controlled; tools and work pieces are mounted	
	• identify the turning capabilities of a lathe; e.g., – types of materials – set-ups – cutters	More and more industries are using computer controlled equipment. Students who enter the machining field will require a knowledge of basic programming principles.
	• observe and note the safety features that are built into the CNC equipment	
• Programming	• identify the relationship of the x and y axis on a metal lathe	Use the Cartesian system to describe a point.
	• determine how to program a lathe using absolute coordinates	
• Dimensioning Systems	• compare the advantages of using incremental and absolute systems of measurements	
	• explain the difference between using a fixed zero and full floating zero	

Concept	Specific Learner Expectations	Notes
• M and G Codes • CAD/CAM	*The student should:* • describe the purpose of M and G codes • explain how canned cycles are used in programming • explain how a CAD file can be converted to a machinable part file.	
Planning and Management • Health and Safety • 2-D Programming	• review the: – appropriate use of protective equipment and clothing – need to keep work area clean and free of hazards – importance of following the manufacturer's instructions and keeping all guards in place in working order • review a safety plan in case of accident • prepare a program from a print using absolute coordinates and/or produce a CAD design • simulate the tool path using computer graphics.	
Implementation • Production	• load the program or convert a CAD file • mount and secure the workpiece • determine reference and clearance points • mount and set cutting tool(s) • carry out a test run • manufacture the part.	

Concept	Specific Learner Expectations	Notes
Assessment • Quality Control • Career Preparation	*The student should:* • inspect the part to see that it meets the print dimensions, tolerances and specifications • maintain a record of completed activities within a portfolio.	

MODULE FAB216: CUSTOM FABRICATION

Level: **Intermediate**

Theme: **Production Systems and Processes**

Prerequisite: **Exploring Production Systems (FAB116; recommended)**

Module Parameters: **Access to fabrication facilities and equipment**

Students work independently, or in a cooperative learning environment, to design, plan and construct a product/structure that meets specific client needs.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• demonstrate appropriate communication and planning skills	• observed communication with a client that includes: – methods used to determine the customer needs – a design proposal and approval – cost and time estimate – contract terms. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	25
• exhibit effective resource management skills and practices	• resource management skills used to access and deploy human and material resources. *Assessment Tool* *(to be developed)* *Standard* *Tools and materials are to be acquired and used effectively; time is to be used efficiently through proper scheduling and time allocation*	25
• demonstrate appropriate custom fabrication competencies	• successful fabrication of a custom product that fulfills the conditions of the contract. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	50

MODULE FAB216: CUSTOM FABRICATION (continued)

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – communication – ethics – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Custom Manufacturing	• review the advantages and disadvantages of custom production	Encourage students to work with a client to determine his or her needs, develop a proposal and complete a project to satisfy the customer rather than simply build a project for themselves.
• Client Needs	• list the steps to follow in determining a client's needs	
• Management Skills	• identify and describe key management elements such as: – organizing – designing – producing – controlling.	

Concept	Specific Learner Expectations	Notes
Planning and Management	*The student should:*	
• Customer Interface	• meet with the customer to determine the product/structure need and limitations • work collaboratively to create a suitable design, time line and budget • apprise the customer of any need to make changes • be open to change orders as the customer sees necessary • conduct a customer satisfaction follow-up	
• Construction and Fabrication Planning	• determine the types and properties of the materials to be used • consider whether any specialized equipment will be needed to complete the task • assess the need to construct special jigs or fixtures • determine if there are any unique finishing and installation requirements	
• Cooperative Work Strategies	• recognize the need to: – identify group and individual responsibilities – identify and capitalize on individual strengths – participate in group as well as self-evaluative processes – develop strategies for positive criticism.	
Implementation		
• Construction and Fabrication	• assign or carry out responsibilities to: – break out materials according to a prearranged plan – process materials with a minimum number of set ups – assemble, finish and prepare the product/ structure for delivery or installation.	

MODULE FAB216: CUSTOM FABRICATION (continued)

Concept	Specific Learner Expectations	Notes
Assessment • Follow-up • Career Preparation	*The student should:* • investigate ways to determine customer satisfaction • determine future service requirements • establish a method for gaining new leads • maintain a record of completed activities within a portfolio.	

MODULE FAB217: PIPE FITTING

Level: **Intermediate**

Theme: **Fabrication Processes**

Prerequisite: **Bar and Tubular Fabrication (FAB111; recommended)**

Module Parameters: **Access to pipe cutting, threading and assembly tools; instructor requires piping skills and experience**

There are many domestic and industrial uses of pipes and pipelines. In this module, students learn basic piping principles, materials and fabrication skills.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify and describe common piping materials and applications	• accurate identification and description of four different pipe materials and appropriate applications. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	25
• demonstrate approved methods of joining common types of pipe and materials	• completion of a simple piping system that incorporates a variety of pipe materials, fittings and components. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *The system should be accurately layout and connected with tight joints: overall workmanship should meet trade expectations* *Performance rating of 3*	60
• identify present and future career opportunities related to pipe trades	• presentation of a career profile that outlines: present and future career opportunities – skill requirements – training opportunities. *Assessment Tool* *Occupation Profile Framework (No. 5.1)* *Standard* *Performance rating of 3*	15

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – communication – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Piping Systems	• investigate and describe the types of piping systems used to provide: – gas supply systems – sprinkler systems – hot water and heating services – steam and superheated steam – cooling systems – petroleum and chemical products	Discuss residential and commercial applications of piping systems.
• Pipe Materials	• identify and provide applications for: – standard pipe (black and galvanized) – thin wall pipe – extra strong (xs) pipe • determine and give examples of how common piping materials are coded and specified	

Concept	Specific Learner Expectations	Notes
	The student should:	
• Pipe Components	• list and describe components found in piping systems; e.g., – flanger and fittings – valves – traps – pumps	
• Joining Pipes	• determine appropriate applications and methods of joining pipe by: – threading – welding – mechanical fasteners	
	• determine how to join dissimilar pipe materials; e.g., – steel pipe to copper – steel pipe to plastic	
• Calculations and Layout	• examine various methods to measure pipe lengths and calculate offsets	
	• identify appropriate methods of laying, hanging and securing pipe.	
Planning and Management		
• Print Reading	• read a given drawing to determine the appropriate type and size of pipe, fittings and components	
	• calculate the length of a given offset.	
Implementation		
• Health and Safety	• observe all safety procedures related to: use of personal protective clothing – lifting heavy weights – use of ladders and scaffolds – use of tools and materials	Students may have to go off campus to gain practical experience in this module.
	• review a safety plan in case of accident	
• Pipe Fabrication	• use the appropriate tools to make a small pipe assembly that incorporates a variety of fittings and components.	

Concept	Specific Learner Expectations	Notes
Assessment	*The student should:*	
• Quality Control	• test a simple pipe assembly for: – accuracy – tightness of joints – overall workmanship	
• Career Information	• investigate career and further training opportunities related to pipe work	
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE CURRICULUM AND ASSESSMENT STANDARDS: ADVANCED LEVEL

The following pages define the curriculum and assessment standards for the advanced level of Fabrication Studies.

> Advanced level modules demand a higher level of expertise and help prepare students for entry into the workplace or a related post-secondary program.

Module FAB301: Material Testing F.3
Module FAB302: Metallurgy and Heat Treating F.7
Module FAB303: Gas Tungsten Arc Welding F.13
Module FAB304: Specialized Welding F.17
Module FAB305: Shielded Metal Arc Welding III F.21
Module FAB306: Shielded Metal Arc Welding IV F.25
Module FAB307: Pipe Welding F.29
Module FAB308: Automated Welding F.33
Module FAB309: Cylindrical and Conical Sheet Fabricating F.37
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Module FAB317: Gas Metal Arc Welding II F.65

MODULE FAB301: MATERIAL TESTING

Level: **Advanced**

Theme: **Materials and Structures**

Prerequisite: **Introduction to Construction and Fabrication (CFS101)**
Fabrication Principles (FAB110; recommended)
The Design Process (DES102; recommended)

Module Parameters: **Access to common hand and power assisted tools; instructor requires basic understanding of material testing principles**

Students are introduced to the principles of materials testing, and to the development and evaluation of a mechanical materials test.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• describe purpose and nature of material testing	• the explanation of four different types of materials tests and their purposes. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	20
• apply testing principles to design and build a piece of test apparatus	• successful completion of a piece of test equipment. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *The apparatus is to be safe, easily used and calibrated; results should be consistent with other forms of testing equipment* *Performance rating of 3*	50
• test and compare the properties of common building materials	• results of a test on three different materials. *Assessment Tool* *Framework for Reporting (No. 2.1)* *Standard* *Results should be effectively communicated and be consistent with current findings*	30

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – communication – ethics – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Types of Tests	• identify and describe common methods of testing materials:	Describe methods of testing for: – compression – tension – impact – shear – fatigue.
• Testing Results	• determine how test results are recorded and communicate a plan showing how to anticipate the results of a test	
• Health and Safety	• identify common hazards associated with the use of a specific tool, material and/or process • inspect for and correct potential hazards within the working environment • review a safety plan in case of accident.	

Concept	Specific Learner Expectations	Notes
Planning and Management	*The student should:*	
• Established Testing Equipment	• design testing station for the test to be completed • establish safety controls • construct testing devices	Have students design and build a piece of test apparatus that can be used to test a particular material property, such as shear strength, torsion, hardness and impact.
• Complete Tests	• secure materials to be tested • prepare the materials as required.	
Implementation • Testing	• conduct a test on a variety of materials and record the test results.	
Assessment • Quality Control/ Reliability	• compare the data obtained from the materials tested to anticipated results • determine the reliability of the testing procedure • identify the advantages/disadvantages of test being carried out.	
• Career Information	• identify further training and career opportunities related to material testing	
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB302: METALLURGY AND HEAT TREATING

Level: **Advanced**

Theme: **Materials and Structures**

Prerequisite: **Material Testing (FAB301; recommended)**

Module Parameters: **Access to basic fabrication and heat treating equipment; instructor requires knowledge of metallurgy and heat treating expertise**

The principles of metallurgy can be applied to all aspects of fabrication. In this module, students develop fundamental understandings and skills related to metallurgy and apply these to fabrication processes.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify and describe the fundamental principles of metallurgy and their industrial applications	• the completion of a written test that covers the application of metallurgy principles in welding, foundry and mechanical forming and finishing techniques. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	20
• identify the basic alloying components and properties of common alloys	• a description of the major alloy components and subsequent properties of four common alloys. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	20
• apply metallurgical principles and skills to heat treat a repair or new product	• successful production or repair of a product that requires heat treating processes *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *An acceptable repair or product should have the characteristics of hardness and toughness as specified in the design specifications* *Performance rating of 3*	60

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Metallurgy	• list and describe the three major fields of metallurgy; i.e., – extractive – mechanical – physical metallurgy	Having a good understanding of the basic principles of metallurgy is important for every serious metals student.
• Metallic Structures	• use the following terms to describe the internal structure of metals; e.g., – atomic structure – compound – solution – crystal	
• Metallurgy Application	• explain how the principles of metallurgy are used in: – welding – foundry – mechanically forming and finishing metals	Student should understand that temperature, time and stress affect the properties of metals.
	• determine the relationship between the properties of a metal and their structure	The structure of a metal can be modified by chemical compositions alloying and heat treating.

Concept	Specific Learner Expectations	Notes
	The student should:	
	• determine the effects of cooling on the size and shape of a crystal	Have students understand that a casting made in a metal mold would likely have a different structure to one made in a sand mold because of the different rates of cooling.
• Alloying	• identify elements that are dissolved together to form common alloys such as: – steel – bronze – brass	
	• describe the effects of adding greater or lesser percentages of carbon to the strength, hardness and brittleness of steel	Note that atoms of other elements often distort the arrangements of the crystals and this changes the characteristics of the metal.
	• identify the basic alloy components and common uses of the following steel types: – carbon steels – alloy steels – tool steels – stainless steels	
• Metal Identification	• review and describe common methods of identifying ferrous and non-ferrous materials such as spark, magnetic and specific gravity tests	
• Corrosion	• describe the electrochemical nature of corrosion	
	• identify common methods of reducing corrosion; e.g., – protective coating – oxide layers – alloys	Students should understand that corrosion is more likely to occur in areas where a structure is under stress and in contact with water.

Concept	Specific Learner Expectations	Notes
• Heat Treating	*The student should:* • compare the effects of heating and cooling on steels with varying carbon contents • describe the process and purpose of: – quenching – normalizing – annealing – tempering – surface hardening • explain how heat treating principles are applied to welding and other fabrication processes	Because of the rapid rate of heat removed adjacent to a weld can often change the properties of the metal in this region.
• Work Hardening	• explain how cold working differs from heat treating.	
Planning and Management • Heat Treating	• determine the procedures and critical temperatures to heat treat one or more of the following tools: – wood chisel – screw driver – center punch – cold chisel • review the safe start-up and shut-down procedures of a heat treating furnace.	
Implementation • Material Fabrication	• use the appropriate materials processes and tools to fabricate and condition a new product or make repairs to an existing product.	
Assessment • Quality Control	• investigate ways to test a product for hardness and toughness	

Concept	Specific Learner Expectations	Notes
• Career Preparation	*The student should:* • maintain a record of completed activities within a portfolio.	

MODULE FAB303: GAS TUNGSTEN ARC WELDING

Level: **Advanced**

Theme: **Fabrication Processes**

Prerequisites: **Oxy-Fuel Welding (FAB203; recommended)**
Shielded Metal Arc Welding II (FAB206; recommended)
Gas Metal Arc Welding I (FAB207; recommended)

Module Parameters: **Gas Tungsten Arc Welding equipment, supplies and facilities; instructor requires formal training and/or appropriate level of experience**

Students develop basic knowledge, skills and attitudes related to the application of Gas Tungsten Arc Welding (GTAW) principles, equipment and supplies to weld mild steel in the flat and horizontal positions.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify the hazards associated with Gas Tungsten Arc Welding (GTAW) and take preventive measures to avoid accidents and personal injury	• observed performance related to: – appropriate selection and use of personal protective equipment – safe use of equipment and supplies – measures taken to ensure the safety of others. *Assessment Tool* *Workplace Safety Assessment Profile (No. 4.1)* *Standard* *Performance rating of 2 on all parts*	15
• outline the advantages of GTAW over other forms of welding	• being able to list four advantages of Gas Tungsten Arc Welding compared to other forms of welding. *Assessment Tool* *Sample List (to be developed)* *Standard* *(to be developed)*	15

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• demonstrate basic flat position and horizontal position Gas Tungsten Arc Welding skills	• completion of mild steel fillet and groove welds in the flat, horizontal and vertical positions. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Weld should be clean and bright, with ripples that are uniformly formed and spaced; penetration should be even throughout the weld* *Performance rating of 3*	70
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	

Concept	Specific Learner Expectations	Notes
	The student should:	
Orientation		
• Occupational Health and Safety	• identify and describe the health and safety issues associated with GTAW such as: – electric current – inert gases – arc radiation – ventilation	This module requires specialized equipment. Students who wish to get credit in this module may need to access this equipment in an off-campus environment.
	• review a safety plan in case of accident	
• Gas Tungsten Arc Welding	• describe the basic components and operating principles of GTAW	
	• identify the advantages of GTAW over other forms of arc welding	

Concept	Specific Learner Expectations	Notes
	The student should:	
• Power Supply	• describe the major types of power supplies and current outputs; e.g., – alternating current (AC) – direct current straight polarity (DCSP) – direct current reverse polarity (DCRP)	
	• determine the appropriate type of current used for welding: – low carbon steel – aluminium – stainless steel	
• Shielding Gases	• explain the purpose of a shielding gas	
	• determine the appropriate type of gas to be used with: – low carbon steel – aluminium – stainless steel	
• Electrodes	• explain the purpose of a shielding gas	
	• select, prepare and install the appropriate electrode for: – AC – DCSP or DCEN – DCRP or DCEP welding	
• Filler Metal	• demonstrate proper handling techniques to prevent weld contamination	
	• identify the degreasers that are commonly used to clean filler materials.	
Planning and Management		
• Start-up and Shut-down	• identify and demonstrate the appropriate start-up and shut-down procedures for welding mild steel	
• Technique	• demonstrate typical methods used to start an arc	
	• determine the correct torch angle for a lap and groove weld in the flat, horizontal and vertical positions	

MODULE FAB303: GAS TUNGSTEN ARC WELDING (continued)

Concept	Specific Learner Expectations	Notes
	The student should:	
• Weld Preparation	• remove all mill scale, rust, paint and oil from the weldments	To avoid weld contamination, stress the importance of having clean surfaces.
• Standards	• list the characteristics of a weld that meets trade standards.	
Implementation		
• Gas Tungsten Arc Welding	• make lap and groove welds in the flat, horizontal and vertical positions.	
Assessment		
• Quality Control	• perform a visual inspection of a weld and describe its characteristics	Welds should be clean and bright; have uniform beads and even penetration.
• Career Information	• identify career opportunities related to GTAW.	

MODULE FAB304: SPECIALIZED WELDING

Level: **Advanced**

Theme: **Fabrication Processes**

Prerequisites: **Oxy-Fuel Welding (FAB203; recommended)**
Gas Tungsten Arc Welding (FAB303; recommended)
Shielded Metal Arc Welding III (FAB305; recommended)
Gas Metal Arc Welding II (FAB317; recommended)

Module Parameters: **Welding equipment, supplies and facilities; instructor requires formal training and/or appropriate level of experience**

Students develop specific skills associated with the use of common welding techniques to join and repair metals other than low carbon steel.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• list the specific hazards associated with welding metals other than low carbon steels	• being able to list the hazards associated with welding metals containing zinc, brass and lead. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	10
• describe the unique welding characteristics of various metals other than low carbon steel	• outlining in report form, the characteristics and methods of welding aluminium, stainless steel and cast iron. *Assessment Tool* *Framework for Reporting (No .2.1)* *Standard* *(to be developed)*	20
• select the appropriate filler material and welding process to weld a metal other than low carbon steel	• performing a given weld on any one or more of the following materials: – aluminium – stainless steel – cast iron. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Performance rating of 2*	70

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – demonstrating responsibility *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Health and Safety	• determine the health hazards connected with welding metals containing zinc, brass and lead • review a safety plan in case of accident	
• Welding Parameters	• investigate and describe the unique welding characteristics of: – stainless steel – cast iron – aluminium – white metal (zinc die cast metal).	Explain why it is difficult to weld these materials.
Planning and Management	• identify a suitable filler metal and flux to join or repair: – stainless steel – cast iron – aluminium – white metal • determine the appropriate joint preparation, supports and techniques for a given metal.	

MODULE FAB304: SPECIALIZED WELDING (continued)

Concept	Specific Learner Expectations	Notes
Implementation • Welding Process	*The student should:* • perform a weld or repair on one or more metals other than a low carbon steel.	
Assessment • Quality Control • Career Preparation	• complete a visual inspection by considering the overall appearance, size and shape of the beads and degree of penetration • maintain a record of completed activities within a portfolio.	

MODULE FAB305: **SHIELDED METAL ARC WELDING III**

Level: **Advanced**

Theme: **Fabrication Processes**

Prerequisite: **Shielded Metal Arc Welding II (FAB206)**

Module Parameters: **Shielded Metal Arc Welding equipment, supplies and facilities; instructor requires formal training and/or appropriate level of experience**

This module explains the role codes and standards have in the welding trade as well as providing the opportunity for students to test welds and build vertical welding skills.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• examine and maintain Shielded Metal Arc Welding (SMAW) equipment and accessories in proper working order	• observed performance related to the examination and maintenance of personal protective equipment, welding accessories and equipment. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	15
• read and interpret weld symbols	• accurate reading of a weld symbol that graphically represents three details such as the type of weld, its location and process. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	15
• demonstrate vertical position (SMAW) competencies on mild steel plate	• completion of two successive single and multiple pass fillet and groove vee welds in the vertical position. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Welds are to be the correct width and height, free of voids, slag inclusion and apparent restarts, undercutting or overlapping; plate surfaces and adjacent beads have adequate penetration and fusion* *Performance rating of 3*	70

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – demonstrating responsibility *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Welding Codes, Standards and Specifications	• explain the purpose of welding: – codes – standards – specifications	Stress the importance of safety and weld quality and explain how codes and standards help achieve this end.
	• identify agencies that establish codes and standards in Canada and the United States; e.g., – Canadian Standards Association (CSA) – American Welding Society (AWS) – Canadian Welding Bureau (CWB)	
• Welding Symbols	• explain the purpose of a weld symbol • identify the basic data included in a welding symbol • show how a welding symbol can be used to specify: – location of a weld – type of weld – welding process – root opening – contour – degree of penetration – type of electrode	Point out that a weld symbol can communicate a great deal of information in a small space and therefore must be fully understood.

Concept	Specific Learner Expectations	Notes
• Testing	*The student should:* • examine common destructive and non-destructive testing methods.	
Planning and Management • Care and Maintenance of Equipment	• before beginning to weld: – examine the condition of cables and lugs – insure adequate air flow for proper cooling – check the condition of all personal protective equipment	
• Print Reading	• use a weld symbol to determine: – location of a weld – type of weld – root opening – type of electrode.	This module has a strong link to Print Reading (FAB202)
Implementation • Shielded Metal Arc Welding	• use the appropriate equipment and supplies to make single and multiple pass fillet and vee groove welds in the vertical position.	E-6010, E6011 and E-7018 electrodes are recommended for this activity.
Assessment • Quality Control	• perform one or more destructive and non-destructive tests on a weld sample	
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB306: SHIELDED METAL ARC WELDING IV

Level: **Advanced**

Theme: **Fabrication Process**

Prerequisite: **Shielded Metal Arc Welding III (FAB305)**

Module Parameters: **Shielded Metal Arc Welding equipment, supplies and facilities; instructor requires formal training and/or appropriate level of experience**

Students apply and extend positional welding skills using a variety of common electrodes.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• explain the effects heating and cooling have on a weld and the weldment	• an oral or written response that describes the effects heating and cooling have on the quality of a weld and the adjacent materials. *Assessment Tool* *Response Rating Scale (No. 2.3)* *Standard* *Performance rating of 2*	10
• demonstrate advanced level Shielded Metal Arc Welding (SMAW) competencies	• perform a variety of welds to trade standards using four different electrodes. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Performance rating of 3*	70
• profile a career related to welding	• presentation of an occupational profile that outlines: – description of the occupation/trade working conditions – employment opportunities – training requirements *Assessment Tool* *Occupation Profile Framework (No. 5.1)* *Standard* *(to be developed)*	20

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – demonstrating responsibility *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Heating and Cooling	• describe the effect of single and multiple pass welds on the base and previously deposited metal • determine the effect cold working conditions might have on weld quality • explain the need to preheat or postheat	
• Electrode Selection	• review the factors to be considered when choosing an electrode; e.g., – weld position – materials to be welded – current supply – ease of use – joint design and alignment – rate of deposit – depth of penetration – weld finish.	

Concept	Specific Learner Expectations	Notes
Planning and Management	*The student should:*	
• Preparation	• review the properties and uses of the following electrodes: – E-6010, 11 and 12 – E-7014, 18 and 24 • select the appropriate rod for a given application • prepare the surfaces for welding • correctly position the weld	
• Equipment Set-up	• adjust the equipment to coincide with the type of electrode, weld and metal thickness.	
Implementation		
• Shielded Metal Arc Welding	• develop entry-level arc welding skills in the flat, horizontal and vertical positions using a variety of weld types, joints, electrodes and thickness of mild steel • prepare welds for testing and assessment.	Welds completed here should be similar to those found in the first period of the apprenticeship program.
Assessment		
• Quality Control	• perform a destructive and non-destructive test where appropriate	Welds should meet first period apprenticeship standards.
• Career Preparation	• determine employment opportunities and further training requirements for the welding trade or related occupation • maintain a record of completed activities within a portfolio.	

MODULE FAB307: PIPE WELDING

Level: **Advanced**

Theme: **Fabrication Processes**

Prerequisites: **Thermal Cutting (FAB204; recommended)**
Shielded Metal Arc Welding III (FAB305; recommended)
Gas Metal Arc Welding II (FAB317; recommended)

Modular Parameters: **Welding equipment supplies and facilities; instructor requires formal training and/or appropriate level of experience**

Students develop specific skills related to pipe layout and preparation of pipe/tube joints and welding techniques.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify the hazards associated with pipe and enclosed vessel welding and take preventive measures to avoid accident and personal injury	• observed performance related to: – appropriate selection and use of personal protective equipment – preparation and selection of equipment and supplies – measures taken to ensure the safety of others. *Assessment Tool* *Workplace Safety Assessment Profile (No. 4.1)* *Standard* *Performance rating of 2 on all points*	10
• describe and demonstrate pipe/tube joint layout and preparation skills	• accurate measurement and layout of joints. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	20
• demonstrate pipe/tube welding competencies	• completion of butt and socket welds using roll and positional welding techniques *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Performance rating of 2*	70

MODULE FAB307: PIPE WELDING (continued)

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – demonstrating responsibility *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
	The student should:	
Orientation		
• Health and Safety	• identify the precautions that must be taken prior to cutting or welding pipe or other enclosed vessel • review a safety plan in case of accident	Stress the importance of knowing what a pipe/vessel has been used for prior to welding.
• Pipe and Tube Welding	• list the advantages of welding over other forms of connecting pipe • identify the standards of certification required for welding: – low pressure water lines or light structural application – medium pressure residential gas lines – high pressure gas lines, motor cycle and aircraft frames.	

Concept	Specific Learner Expectations	Notes
Planning and Management • Pipe/Tube Preparation	*The student should:* • calculate the cut angle for a butt joint in relation to the wall thickness and intended application • prepare a template for: – 90° two-piece turn – full T-joint – full lateral joint – butt joint • select an appropriate welding process.	
Implementation • Welding Process	• perform a butt weld using roll and position welding techniques • prepare and perform: – full T-joint – full lateral joint tube and pipe weld.	
Assessment • Quality Control • Career Preparation	• apply suitable destructive and non-destructive tests to ensure weld quality • maintain a record of completed activities within a portfolio.	

MODULE FAB308: AUTOMATED WELDING

Level: **Advanced**

Theme: **Fabrication Processes**

Prerequisites: **Oxy-Fuel Welding (FAB203; recommended)**
Thermal Cutting (FAB204; recommended)
Shielded Metal Arc Welding II (FAB206; recommended)
Gas Metal Arc Welding II (FAB317; recommended)

Modular Parameters: **Automated welding equipment supplies and facilities; instructor requires formal training and/or appropriate level of experience**

Students investigate various machine and automated welding processes and systems.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• explain how manual, machine and automated welding processes are different from one another	• accurate description of each technique that outlines the essential differences and similarities between manual, machine and automated welding processes. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	20
• apply knowledge of advanced welding processes	• presentation or demonstration of a working or simulated production welding system. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	60
• identify employment and further training opportunities related to production welding	• presentation of an occupational profile that outlines the: – description of the trade/occupation and working conditions – employment opportunities – training requirements and opportunities. *Assessment Tool* *Occupation Profile Framework (No. 5.1)* *Standard* *(to be developed)*	20

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – communication – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation • Health and Safety	*The student should:* • identify the hazards associated with specific machine and automated processes • describe methods that are commonly used to protect an individual from injury by an automated system; e.g., robot • review a safety plan in case of accident	

MODULE FAB308: AUTOMATED WELDING (continued)

Concept	Specific Learner Expectations	Notes
• Production Processes	*The student should:* • explain the difference between: – manual – machine – automated cutting and welding processes • describe the specialized welding techniques that are suitable for machine or automated processes; e.g., – resistance welding – GMAW – GTAW – plasma arc cutting – laser beam welding and cutting	Students will likely need to go off-campus to observe automated cutting and welding processes.
• Robotic Welding and Cutting	• investigate the use of robots in welding to determine their advantages and disadvantages • identify the main types of robots and describe their work envelope • identify the main parts of a robot and the components of a welding station • describe the use of a teach pendent in programming a robot to perform the designated task.	
Implementation • Application	• demonstrate or simulate a viable production system using semi- and/or fully automated processes.	
Assessment • Career Preparation	• identify career opportunities related to the use of automated welding processes in industry • maintain a record of completed activities within a portfolio.	

MODULE FAB309: CYLINDRICAL AND CONICAL SHEET FABRICATING

Level: **Advanced**

Theme: **Fabrication Processes**

Prerequisite: **Sheet Metal Fabrication II (FAB210)**

Module Parameters: **Access to shearing, forming, fastening and layout tools; instructor requires sheet metal experience and expertise**

Students develop specialized skills in pattern development and seam construction related to the use of ferrous and non-ferrous metals.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• describe the procedures that are used to lay out a typical cylindrical and conical shape	• accurate identification and description of parallel and radial line layout procedures. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	10
• demonstrate parallel and radial line pattern making skills	• application parallel and radial line development processes to produce a cylindrical and conical pattern. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	25
• perform advanced cylindrical and conical sheet stock fabrication skills	• successful completion of sheet metal products that incorporate cylindrical and conical shapes. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *The products are to be structurally sound, free of surface blemishes and hazards; and conform to stated overall sizes, shapes and tolerances* *Performance rating of 3*	65

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – communication – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Ferrous and Non-ferrous Stock	• determine the properties of: – copper – brass – stainless steel – tin plate • determine which materials are most malleable • examine the techniques that are used to raise form sheet stock	
• Fabrication Processes and Tools	• determine the type of pattern development that is used to lay out a: – cylinder – cone – rectangle to round • explain when single, double, grooved and wired seams are used in conjunction with cylindrical and conical fabrication • identify and describe the use of the following solder coppers: – square point – bottoming – roofing.	

Concept	Specific Learner Expectations	Notes
Planning and Management	*The student should:*	
• Measurement	• use a micrometer caliper to measure the thickness of a piece of sheet stock • calculate the inside, outside and mean diameter of a cylindrical component • identify the correct formula to calculate the allowances for seam and edges	
• Product Design	• choose a product that incorporates: – cylindrical and conical shapes – grooved and double seams – raised surfaces and finished edges – solder joints – two or more different materials • select the appropriate material for a given product and finish • create the necessary pattern development, using a computer or conventional means.	Students may require additional assistance and time to create a conical pattern.
Implementation		
• Material Processing	• use the appropriate tools, materials and processes to: – cut and bend sheet stock – raise and finish a surface – locate and make joints watertight	
• Personal and Tool Safety	• wear personal protective clothing and equipment • keep tools in working order • handle store and discard metal cut-offs in a correct manner.	
Assessment		
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB311: DUCT COMPONENTS

Level: **Advanced**

Theme: **Fabrication Processes**

Prerequisite: **Sheet Metal Fabrication II (FAB210)**

Module Parameters: **Access to shearing, forming, fastening and layout tools; instructor requires sheet metal experience and expertise**

Students apply and develop specialized skills in duct component pattern making and construction techniques.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify common duct components and applications	• accurate identification and description of: – radius elbow – riser – offset – branch tie – take-off components. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	10
• demonstrate the use of triangulation to create a transition pattern	• application of triangulation principles to produce a transition pattern. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	25

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • perform pattern transfer and duct making skills	*Assessment of student achievement will be based on:* • successful completion of two or more interconnecting duct components. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *The components are to be structurally sound and air tight; surfaces are to be free of blemishes and hazards. Components should be constructed to meet stated sizes and tolerances* *Performance rating of 3*	65
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation • Ducting	*The student should:* • prepare a list of duct system applications • list and state the purpose of the following components used in a duct system: – radius elbow – riser – offset – branch tee – take off • describe how air volume and pressures are measured	Explain why it is important for duct components to be sized accurately.

Concept	Specific Learner Expectations	.Notes
	The student should: • examine the effect of component resistance on static and velocity air pressures in a ducting system	
• Fabrication Processes	• list and describe the use and construction of the following joints: – S and drive – T-lock – hammerlock – government locks • state the advantages and disadvantages of using each of the above systems • differentiate among the use of parallel line, radial line and triangulation in pattern development.	
Planning and Management • Pattern Development	• calculate the material allowance for: – S and drive – T-lock – hammerlock • use triangulation to develop a pattern for an object whose sides are not parallel.	Students may require additional assistance and time to develop a pattern.
Implementation • Material Processing	• use the appropriate tools, materials and processes to fabricate specific components in a ducting system.	
Assessment • Career Assessment • Career Preparation	• describe the trade qualifications and work opportunities related to sheet metal fabrication • maintain a record of completed activities within a portfolio.	

MODULE FAB312: FOUNDRY III (CORE MOLDING)

Level: **Advanced**

Theme: **Production Systems and Processes**

Prerequisites: **Foundry I (FAB112; recommended)**
Foundry II (FAB212; recommended)

Module Parameters: **Access to foundry equipment, supplies and foundry expertise**

Students investigate and apply advanced foundry processes to produce a hollow casting using a sand mold and core.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• list and describe common core materials and production processes	• written or oral report that: – describes how cores are designed and fabricated – lists four different core binders and setting techniques – explains how cores are placed and reinforced in a mold. *Assessment Tool* *Framework for Reporting (No. 2.1)* *Standard* *(to be developed)*	10
• demonstrate advanced casting skills using coring techniques	• completion of a hollow casting using an appropriate coring technique. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *The core should break down at the end of the casting process and be easily removed. The casting should be clean and free of voids and meet size, shape and finish expectations* *Performance rating of 3*	70

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• identify further training and employment opportunities related to foundry work	• presentation of an occupational profile that outlines: – description of the trade/occupation and conditions of work – employment opportunities – training requirements and opportunities. *Assessment Tool* *Occupation Profile Framework (No. 5.1)* *Standard* *(to be developed)*	20
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	

Concept	Specific Learner Expectations	Notes
	The student should:	
Orientation		
• Cores	• explain the purpose of a core and provide examples of products that require their use in casting	An engine block is a good example of a part that requires cores.
	• describe the variables and characteristics of good core mix	
• Binders	• identify common binders that can be used with core sand; e.g., sodium silicate and CO_2, linseed oil, wheat flour and molasses and other commercially prepared products	

Concept	Specific Learner Expectations	Notes
	The student should:	
• Core Construction	• identify common shapes and methods of producing and drying a core	
• Core Placement	• investigate and describe common methods of supporting core in mold cavity.	
Planning and Management		
• Core Design	• for a given casting and material, identify the appropriate core shape placement technique, core mix and reinforcement techniques	
	• prepare a sketch showing the location of: – parting line and type of mold – core and core prints	
	• venting, gating and pouring system for a given casting	
• Health and Safety	• review safety concerns related to: – personal protective equipment – mold construction – foundry furnace start-up and shut-down procedures – heating and pouring procedures	
	• cleaning and finishing castings	
	• review a safety plan in case of accident	
• Material Processing	• create a casting using common pattern making, coring and pouring techniques	Begin with a simple part such as a hollow cylinder that could later be machined into a collar or bushing.
	• clean and finish the casting according to specification.	
Assessment		
• Quality Control	• check the overall size, shape and structural soundness of the product	
• Career Information	• investigate employment opportunities related to foundry work	
	• identify ways to gain experience and further training in foundry work	

Concept	Specific Learner Expectations	Notes
• Career Preparation	*The student should:* • maintain a record of completed activities within a portfolio.	

MODULE FAB313: ADVANCED LATHE WORK

Level: **Advanced**

Theme: **Production Systems and Processes**

Prerequisite: **Precision Lathe Work (FAB213)**

Module Parameters: **Access to a metal lathe and accessories; instructor requires machining training and experience**

Students develop specialized lathe skills in thread cutting and taper turning techniques.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• demonstrate print reading and job sequencing competencies	• application of print reading and sequencing skills to prepare logical, efficient and safe sequence of machining operations. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	20
• perform safe taper turning and thread cutting set-up procedures	• demonstration of approved practices to set up a lathe for: – taper turning – thread cutting. *Assessment Tool* *Metal Lathe Performance Checklist, Parts C and D (to be developed)* *Standard* *All tasks performed to a satisfactory level*	10

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• perform taper turning and thread cutting operations	• completion of the following machining operations: – outside and inside tapers – outside and inside right hand threading. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Dimensions, levels of finish and fits are to be within stated tolerances and specifications* *Performance rating of 3*	70
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – being innovative – communication – demonstrating responsibility *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	

Concept	Specific Learner Expectations	Notes
	The student should:	
Orientation		
• Health and Safety	• review and describe the hazards associated with metal lathes and metal cutting operations • review a safety plan in case of accident	
• Lathe Accessories	• list and describe common lathe accessories such as drill chuck, taper attachment, tool post grinder and thread dial	

Concept	Specific Learner Expectations	Notes
	The student should:	
• Taper Turning	• list and describe specifications, uses and size descriptions of the following: – Morse taper – standard milling machine taper – taper pins	
	• observe methods of cutting a taper by using the: – compound rest – tailstock offset – taper attachment methods	Demonstrate these processes on the lathe.
	• identify the factors that determine the most efficient method of cutting a taper such as the: – length and angle of taper – quality of finish – quantity	
• Threading	• identify the parts of a thread	
	• list and describe the principal features of a: – Unified National Coarse (UNC) – Unified National Fine (UNF) – tapered pipe thread – IS0 metric thread	
	• observe and record the set-up procedures to cut internal and external left- and right-handed threads	
	• describe the classes of fit associated with Unified Thread system	
• Grinding	• observe and describe the set-up and use of a tool post grinder.	
Planning and Management		
• Print Reading	• use a machine drawing to determine the: – overall size and shape of a machine part – thread type, size, tolerance and fit – taper type, size and fit – materials	

Concept	Specific Learner Expectations	Notes
• Work Sequencing	*The student should:* • create a systematic sequence of operations to machine a given part • calculate the appropriate cutting speeds, feed rates and depth of cuts for a given operation.	
Implementation • Taper Turning and Thread Cutting	• build skills in: – inside and outside taper turning – cutting inside and outside threads.	
Assessment • Career Information • Career Preparation	• describe career and further training opportunities related to precision lathe work • maintain a record of completed activities within a portfolio.	

MODULE FAB314: ADVANCED MILLING

Level: **Advanced**

Theme: **Production Systems and Processes**

Prerequisite **Precision Milling (FAB214)**

Module Parameters: **Access to a vertical or horizontal mill; instructor requires formal machining training and machining expertise**

Students develop specialized skills in using vertical and/or horizontal milling machines.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• demonstrate print reading and job sequencing competencies	• application of print reading and sequencing skills to prepare a logical, efficient and safe sequence of milling operations. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	20
• perform safe vertical and/or horizontal mill set-up procedures	• demonstrate approved practices to set up a vertical or horizontal mill to cut: – grooves – keyways – gear teeth. *Assessment Tool* *Milling Machine Performance Checklist, Part B* *(to be developed)* *Standard* *All points covered to a satisfactory level*	10

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student assessment will be based on:*	
• perform groove keyway and gear cutting operations	• completion of the following: – groove – keyway – gear cutting operations. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Dimensions and levels of fit are to be within the stated tolerances and specifications* *Performance rating of 3*	70
• demonstrate effort to develop basic competencies.	• observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – being innovative – communication – demonstrating responsibility *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
	The student should:	
Orientation		
• Health and Safety	• review and describe the hazards associated with manual milling operations • review a safety plan in case of accident	
• Milling Operations	• observe and describe safe set-up procedures to mill grooves, keyways and gear teeth	

Concept	Specific Learner Expectations	Notes
	The student should:	
• Cutters	• identify and describe the types of cutters that are available for cutting common grooves, keyways and gear teeth • explain the difference between a high speed steel and a tungsten carbide cutter • identify the conditions that produce cutter failure such as: – excessive heat – clogging – work hardening	Teacher should be prepared to demonstrate each of these processes.
• Indexing	• identify common machine parts that require indexing • describe how an indexing head is used to cut a simple gear.	
Planning and Management • Print Reading	• use a machine drawing to determine: – overall size and shape of a machine part – specific types and sizes of grooves, keyways and gear teeth	
• Work Sequencing	• list and describe the machining operations for a given machine part and/or feature in a logical sequence • identify the appropriate type of mill and cutters for each operation • select work piece holding device • calculate the appropriate cutting speeds, feed rates and recommended depths of cut for a given operation • select appropriate cutting fluids.	

Concept	Specific Learner Expectations	Notes
Implementation	*The student should:* • build skills in milling: – grooves – keyways – gear teeth.	
Assessment • Career Information	• identify career and further training opportunities related to precision milling	Remind students that conventional machining processes will remain; however, new methods such as laser, electric and electro-chemical processes are emerging as alternative ways of machining.
• Career Preparation	• maintain a record of completed activities within a portfolio.	

MODULE FAB315: COMPUTER NUMERICAL CONTROLLED MILLING

Level: **Advanced**

Theme: **Production systems and Processes**

Prerequisite: **Computer Numerical Controlled (CNC) Turning (FAB215)**

Module Parameters: **Access to a CNC milling centre; instructor requires CAD and CNC programming skills and machining experience**

Students develop skills in CAD and CNC programming to manufacture a three-dimensional product.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• demonstrate three-dimensional programming and/or CAD skills	• development of a 3-D program to produce a machinable part on a CNC mill using absolute coordinates, canned cycles and/or CAD file conversion. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	50
• operate a CNC mill to manufacture a milled part	• performing the appropriate set-up testing and running procedures to produce a milled part. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	30
• identify further training and employment opportunities related to CNC machining	• presentation of an occupational profile that outlines: – description of the occupation and conditions of work – employment opportunities – training requirements and locations. *Assessment Tool* *Occupation Profile Framework (No. 5.1)* *Standard* *(to be developed)*	20

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – demonstrating responsibility *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• Mill Operation	• observe the operation of a CNC mill and determine how the cutting speeds, feed rates and depth of cuts are controlled; cutting tools and workpieces are mounted • identify milling capabilities of a given machine, e.g., size of cutters, size and types of materials • observe and note the safety features that are built into the CNC equipment	Demonstrate how to program and use a CNC mill using pre-designed/programmed part.
• Programming	• identify the relationship of the x, y and z axis on a vertical milling machine • determine how to program a CNC mill using absolute coordinates	
• Canned Cycles	• review the types of canned cycles used in machining operations • identify when to use canned cycles to improve efficiency • list the information required to calculate and format a canned cycle.	

Concept	Specific Learner Expectations	Notes
	The student should:	
Planning and Management		
• Health and Safety	• review the: – appropriate use of personal protective equipment – importance of keeping all covers and guards in place and following the manufacturer's recommendations – need to keep the work area clean and free of personal hazards • review a safety plan in case of accident	
• 3-D Programming	• prepare a program from a print using absolute coordinates and/or produce a CAD design.	
Implementation	• load the program or covert a CAD file • mount and secure the workpiece • determine reference and clearance points • mount and set cutting tool(s) • carry out a test run • manufacture the part.	
Assessment		
• Quality Control	• inspect the part to see that it meets the print dimensions, tolerances and specifications	Note: This field is expanding as new technology is developed and applications are found.
• Career Information	• research and describe further education and work opportunities related to the use of computer-controlled equipment.	

MODULE FAB316: PREFABRICATION PRINCIPLES

Level: **Advanced**

Theme: **Production Systems and Processes**

Prerequisite: **Custom Fabrication (FAB216; recommended)**

Module Parameters: **Access to fabrication facilities and equipment**

Students work in a cooperative learning environment to design and construct a prefabricated product/structure to meet the specific needs of a customer.

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• perform basic shop drawing take-off skills	• development of an accurate cutting list and fabrication flow chart. *Assessment Tool* *(to be developed)* *Standard* (to be developed)	20
• exhibit advanced resource management competencies	• resource-management skills used to access and deploy human and material resources. *Assessment Tool* *(to be developed)* *Standard* *Jigs and fixtures are to be developed and appropriate tools and materials acquired and used efficiently through proper scheduling and time allocations*	20
• demonstrate appropriate prefabrication skills and practices	• successful prefabrication of a component that fulfills the design specifications and quantity required. *Assessment Tool* *(to be developed)* *Standard* *(to be developed)*	60

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – communication – ethics – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation • Prefabrication Principles	*The student should:* • cite examples of products that are built from prefabricated parts • review the advantages and disadvantages of prefabricating a component • identify specific design considerations that must be adhered to when using prefabricated components • examine procedures that are used to create a cutting list from a sharp drawing • observe and note safe rigging procedures that are used to move materials and components.	Greater efficiency and productivity are achieved by using prefabrication processes. However, extra care must be taken to ensure that components have been accurately designed and fabricated in the shop prior to the assembly on site.

MODULE FAB316: PREFABRICATION PRINCIPLES (continued)

Concept	Specific Learner Expectations	Notes
Planning and Management • Quality Customer Service	*The student should:* • create a cutting list from a shop drawing • prepare the required templates figs and fixtures • locate appropriate materials and supplies • identify specialized equipment and processes that will be required • prepare production flow chart • meet with the customer to determine the product/structure need and limitations • work collaboratively to create a suitable prefabricated design, time line and budget • apprise the customer of any need to make changes • be open to change orders as the customer sees necessary	Good communication between the customer, designer engineer and fabricator is a must. Students need to develop their interpersonal and communication skills.
Implementation • Material Processing	• assign responsibilities to: – break out materials according to a prearranged plan – process materials with a minimum number of set-ups – assemble, finish and prepare the product for delivery • recognize the need to: – identify group and individual responsibilities – identify and capitalize on individual strengths • aid in the installation/assembly of the product if contracted.	
Assessment • Quality Control • Career Preparation	• participate in group and self-evaluation processes • develop strategies for positive criticism • conduct a customer satisfaction follow-up survey • maintain a record of completed activities within a portfolio.	Students need to understand the importance of having good intra and interpersonal skills.

MODULE FAB317: GAS METAL ARC WELDING II

Level: **Intermediate**

Theme: **Fabrication Processes**

Prerequisite: **Gas Metal Arc Welding I (FAB207)**

Module Parameters: **Gas Metal Arc Welding equipment, supplies and facilities; instructor requires formal training and experience**

Students develop specific skills to assess and improve the quality of Gas Metal Arc Welding (GMAW).

Curriculum and Assessment Standards

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will:	*Assessment of student achievement will be based on:*	
• describe the visual characteristics of a quality Gas Metal Arc Welding (GMAW) weld	• being able to list five attributes that describe the visual characteristics of a weld that meets trade standards. *Assessment Tool* *Response Rating Scale* *Standard* *Response rating of 2*	20
• identify strategies to evaluate and improve weld quality	• proper assessment of a weld given a cross-section and plan view and list of corrective measures to improve weld quality. *Assessment Tool* *Exemplar, Reading Welds (to be developed)* *Standard* *(to be developed)*	10
• demonstrate flat position, horizontal position and vertical position (GMAW) competencies on mild steel plate	• completion of two successive single and multiple pass fillet and groove welds in the flat, horizontal and vertical positions. *Assessment Tool* *Task Performance Appraisal (No. 1.1)* *Standard* *Welds are to be free of surface and sub-surface porosity, show no evidence of burn through, lack of penetration or fusion* *Performance rating of 3*	70

Module Learner Expectations	Assessment Criteria and Conditions (Draft)	Suggested Emphasis
The student will: • demonstrate effort to develop basic competencies.	*Assessment of student assessment will be based on:* • observations of individual effort and interpersonal interaction during the instructional period, emphasizing: – managing learning – managing resources – teamwork and leadership – being innovative – demonstrating responsibility. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Learner Expectations	Notes
Orientation	*The student should:*	
• GMAW Variables	• identify the parameters that can directly affect weld quality; e.g., – weld current and voltage – type of gas – diameter and types of filler metal – type and condition of equipment	Explain why changes to the welding current can greatly affect the quality of a weld.
• Gas Mixtures	• select the appropriate gas mixture based on: – mode of metal transfer – base metal type and thickness – joint design – filler material – desired weld quality	
• Filler Metals	• determine how to select the type and size of filler metal • explain how to avoid contamination of filler materials	

Concept	Specific Learner Expectations	Notes
	The student should:	
• Arc Control	• establish the relationship between: – wire speed and amperage – welding voltage and arc gap • determine the effects of: – backhand or pull welding – forehand or push welding • determine the effects of torch angle on: – weld penetration – weld appearance	
• Weld Quality	• identify the probable causes of the following defects: – surface porosity – sub-surface porosity – lack of fusion – burn through – lack of penetration.	
Planning and Management		
• Set-up	• determine the appropriate gas and flow rate, filler wire and feed rate and current setting for a give weld.	
Implementation		
• Gas Metal Arc Welding	• make single and multipass fillet and groove welds on mild steel plate in the flat, horizontal and vertical positions	
• Weld Troubleshooting	• determine the corrective actions that can be taken to avoid: – surface porosity – sub-surface porosity – lack of fusion – burn through – lack of penetration.	Students may also be encouraged to use flux cored wire in this module since this process is gaining in use.

Concept	Specific Learner Expectations	Notes
Assessment	*The student should:*	
• Quality Control	• carry out destructive and non-destructive test where appropriate	
• Career Assessment	• determine employment and further training opportunities for GMAW	
• Career Preparation	• maintain a record of completed activities within a portfolio.	

FABRICATION STUDIES

ASSESSMENT TOOLS

(DRAFT)

ASSESSMENT TOOLS

FABRICATION STUDIES

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BASIC COMPETENCIES REFERENCE GUIDE

The following basic competencies (KSA) are integrated throughout the CTS program. A student's performance and growth should be assessed through observations involving the student, the teacher, peers and others. As the student progresses through the levels, he or she builds on competencies gained in earlier levels.

	Basic Competency	Stage 1	Stage 2	Stage 3
Personal Management	Managing Learning	*The student will:* ☐ be able to identify/locate appropriate reference/ information sources ☐ identify and demonstrate a variety of learning skills and tools; e.g., learning styles/ preferences and strategies such as notemaking, concept mapping, etc.	*The student will:* ☐ apply a variety of learning styles/preferences to enhance ability to acquire new information recall and apply knowledge	*The student will:* ☐ draw and defend conclusions from available information ☐ extract rules or principles ☐ apply rules and principles to new situations
	Being Innovative	☐ recognize opportunities and problems ☐ specify goals and constraints ☐ generate alternatives ☐ consider risks ☐ evaluate and select best alternative	☐ think critically and act logically to evaluate situations, solve problems and make decisions	☐ combine ideas or information in new ways ☐ make connections between seemingly unrelated ideas ☐ prepare, validate and implement plans that reveal new possibilities
	Ethics	☐ identify appropriate ethical behaviour	☐ demonstrate appropriate ethical behaviour	☐ encourage and support others to demonstrate ethical behaviour
	Managing Resources	☐ allocate time effectively by selecting relevant, goal-related activities, ranking them in order of importance, allocating time, and preparing and following schedules.	☐ allocate materials and use facilities effectively by acquiring, storing, and distributing materials, supplies, parts, equipment, space, or final products in order to make best use of them.	☐ allocate human and other resources effectively by assessing knowledge and skills, distributing work and materials, evaluating performance and providing feedback.
Social Interactions	Communication	☐ prepare and effectively present accurate, concise written, visual and oral reports	☐ communicate thoughts, feelings, and ideas to justify or challenge a position by encouraging, persuading, convincing or otherwise motivating individuals or groups	☐ negotiate effectively by working towards an agreement that may involve exchanging specific resources or resolving divergent interests
	Teamwork, Leadership and Service	☐ participate as an effective member of a team by working cooperatively with others and contributing ideas, suggestions and effort ☐ recognize and respect peoples' diversity and individual differences	☐ serve clients and customers effectively by listening carefully to understand their needs and by providing as much assistance as possible to satisfy their expectations	☐ lead when appropriate, mobilizing the group for high performance
	Demonstrating Responsibility (Safety and Accountability)	☐ demonstrate high standards in attendance and punctuality ☐ be trustworthy and honest in dealing with others ☐ follow safe procedures consistently and recognize and eliminate potential hazards.	☐ understand and evaluate the impact on self and the organization for breaking with organizational or societal values and regulations.	☐ work hard to excel at setting and meeting goals, doing tasks, setting high standards and paying attention to important details.

Competency: _____

_____

_____

_____

Task Performance Appraisal No. 1.1

Name: _____

Module: _____

Directions:

Use the following rating scale to describe the student's level of competency.

Standard: (unless stated otherwise)

Introductory Level - Performance Rating of 2
Intermediate Level - Performance Rating of 3
Advanced Level - Performance Rating of 4

The student has:

5. completed the task by exceeding the expectations as outlined. Problems were solved in effective and creative ways. Tools and materials were used efficiently and confidently while maintaining consistent standards of high quality and productivity.
4. completed the task as outlined with limited assistance. Demonstrated good planning and problem-solving skills. Tools and materials were used safely and efficiently to achieve a high standard of quality and productivity.
3. completed the task with some guidance. The student may have required assistance in planning and solving problems and in the selection and use of tools and materials. No major deficiencies and/or errors were noted in the student's work.
2. completed the task by following a guided course of action. Minor deficiencies and/or errors may be evident in the student's work.
1. not completed the task. Major deficiencies and/or errors are evident in the student's work.

Task:

_____

_____

_____

_____

_____

Performance Rating:

5	4	3	2	1
☐	☐	☐	☐	☐

CAREER AND TECHNOLOGY STUDIES

Framework for Reporting No. 2.1

Name: _____

Module _____

Assignment: _____

Date: _____

Consider the following aspects of reporting to determine whether or not the student's work is at or above standard.

RATING SCALE	CRITERIA	RATING
The student has: 4. exceeded the expectations as outlined in the criteria for the report in an effective and creative way. There are no errors and/or deficiencies noted. 3. demonstrated extra effort in meeting the criteria of the report. There are no major errors and/or deficiencies noted. 2. met a minimum standard even though minor errors and/or deficiencies are evident. 1. not met the standard. There are major errors and/or deficiencies noted.	**Preparation and Planning** *The report shows evidence that the student:* – demonstrated personal initiative to formulate questions and find answers – used appropriate in school and/or community resources – organized research in an effective manner. **Presentation Techniques** *The report shows evidence that the student:* – provided an introduction, and followed a logical order of presentation sequencing – communicated in a manner that can be easily understood – provided evidence to justify or challenge a position – used appropriate mechanics of writing and/or oral and visual techniques – stated a conclusion based on a summary of facts. **Content Features** *The report shows evidence that the student:* – covered the scope of the assignment – recorded information accurately and fairly – used the appropriate technical terms – recognized sources of information.	4 3 2 1 N/A ☐ ☐ ☐ ☐ ☐ 4 3 2 1 N/A ☐ ☐ ☐ ☐ ☐ 4 3 2 1 N/A ☐ ☐ ☐ ☐ ☐

MARKING SCHEDULE			
	Mark Possible	**Mark Achieved**	
Preparation and Planning			
– demonstrated personal initiative to formulate questions and find answers	5		
– used appropriate in-school and/or community resources	5		
– organized research in an effective manner.	5		
Presentation Techniques			
– provided an introduction, and followed a logical order of presentation sequencing	5		
– communicated in a manner that could be easily understood	5		
– provided evidence to justify or challenge a position	5		
– used appropriate mechanics of writing and/or oral and visual techniques	5		
– stated a conclusion based on a summary of facts.	5		
Content Features			
– covered the scope of the assignment	5		
– recorded information accurately	5		
– used the appropriate technical terms	5		
– recognized sources of information.	5		
Total:	60		**%**

Activity: _____	**Response Rating Scale No. 2.2**	Name: _____ Module: _____

Directions:
Rate the student's response according to the following rating scale to indicate the degree of competency.

Standard:
As stated in the module.

Criteria	Rating
Excellent Response: • Is communicated effectively in a clear and authoritative manner; covers all points and reveals a superior knowledge base.	4
Good Response: • Is communicated clearly and covers all major points; response demonstrates a strong knowledge base.	3
Satisfactory Response: • Is somewhat limited but generally free from error. Further questioning may be necessary to draw out a more complete response.	2
Nearly Satisfactory Response: • Is incomplete; further questioning reveals limited knowledge base.	1

Competency:
O.A.W.
Start-up &
Shut-down Procedures

Performance Checklist No. 3.1

Name: _____

Module: _____

Directions:
Use the following criteria to assess the student's ability to safely start up and shut down an oxyacetylene torch.

Standard:
Students should satisfy the teacher that all of these steps can be performed correctly and in the proper sequence.

CRITERIA	Observed	Not Observed
* **Start-up Procedures:** *the student:*		
• checked the condition of the workstation and cleared it of all physical hazards	☐	☐
• visually checked the torch valves, hoses, regulators, gauges and cylinders for possible damage	☐	☐
• turned off both torch needle valves before opening cylinder valves	☐	☐
• backed off both regulator adjusting screws before opening the cylinder valves	☐	☐
• opened the oxygen valve all the way	☐	☐
• individually purged the oxygen and acetylene lines before lighting the torch	☐	☐
• opened the acetylene needle valve one half turn	☐	☐
• lit the gas using a spark lighter	☐	☐
• adjusted the acetylene pressure so that an appropriate gap appeared between the tip and the flame - usually 6 mm (1/4")	☐	☐
• opened the oxygen needle valve	☐	☐
• produced a neutral flame using the oxygen regulator adjusting screw	☐	☐

* **Procedures may differ according to each equipment manufacture.**

Performance Checklist No. 3.1 (continued)

CRITERIA	Observed	Not Observed
Shut-down procedure: *the student:*		
• closed the acetylene torch valve before the oxygen valve	❑	❑
• closed the oxygen cylinder valve	❑	❑
• released the pressure from the oxygen line	❑	❑
• backed off the pressure adjusting screw properly	❑	❑
• closed the oxygen torch valve	❑	❑
• followed the same sequence of operation for draining the acetylene	❑	❑
• stored the torch and other accessories as directed	❑	❑

Attempt	1st	2nd	3rd
Competency:	Demonstrated Satisfactorily ❑	Demonstrated Satisfactorily ❑	Demonstrated Satisfactorily ❑
	Not Yet Demonstrated ❑	Not Yet Demonstrated ❑	Not Yet Demonstrated ❑
Date:			

Activity _____ _____	**Workplace Safety Assessment Profile No. 4.1**	Name: _____ Module: _____

Directions: Circle the appropriate number that best describes the student's performance.	**Standard:** As stated in the module.

CRITERIA	Teacher Assessment
Use of Personal Protective Equipment: **focus on the proper selection and use of protective clothing and equipment**	
• identifies potential hazards and risks, selects and wears the appropriate personal protective equipment	3
• usually recognizes potential hazards and takes the necessary precautions	2
• hazards and risks must be pointed out and use of personal protective equipment must be enforced.	1
Housekeeping Skills: **consider effort given to maintaining a clean and tidy workstation**	
• keeps workstation free from unnecessary materials and willingly participates in the overall lab clean-up	3
• generally maintains a clean and tidy workstation and participates in lab clean-up activities	2
• often must be reminded to keep workstation free of clutter and obstructions and requires specific lab clean-up directions and follow-up.	1
Use of Materials: **consider how materials are handled and processed**	
• materials are handled and prepared with due care for self and others	3
• normally demonstrates acceptable practices concerning the use and handling of project materials	2
• is often not aware of the need to handle and use materials in a safe manner.	1
Use of Equipment: **focus on the safe use of hand and power tools**	
• follows accepted practice for the safe use and maintenance of hand and power tools	3
• normally demonstrates acceptable tools use and maintenance	2
• will take unnecessary risks unless directed otherwise.	1

Competency: Materials Handling and Storage	**Performance Check List No. 4.2**	Student: _____ Module: _____

Directions:

Use the following scale to describe the students' ability to handle materials safely

[4] - Highly skilled
[3] - Skilled
[2] - Moderately Skilled:
[1] - Unskilled:

Standard: (unless stated otherwise)

Introductory Modules [2]
Intermediate Modules [3]
Advanced Modules [3]

The student:

• determines the correct method of handling materials before attempting to move them	☐
• uses the appropriate lifting or carrying equipment and personal protective equipment, if required	☐
• requests assistance when moving oversize and/or over-weight objects	☐
• uses proper lifting and handling techniques related to hand placement, foot stance and posture	☐
• uses appropriate supports to facilitate handling and to avoid damage to the materials	☐
• returns and properly stores all unused materials after use	☐

Occupation: _____ _____	**Occupation Profile Framework No. 5.1**	Student: _____ Module: _____

Directions:

Assess the student's occupation profile according to the following outline.

Note: Students may not have been required to cover all points. Adjust standard accordingly.

Standard:

Exceeds	40 - 50
Meets	25 - 40
Below	less than 25

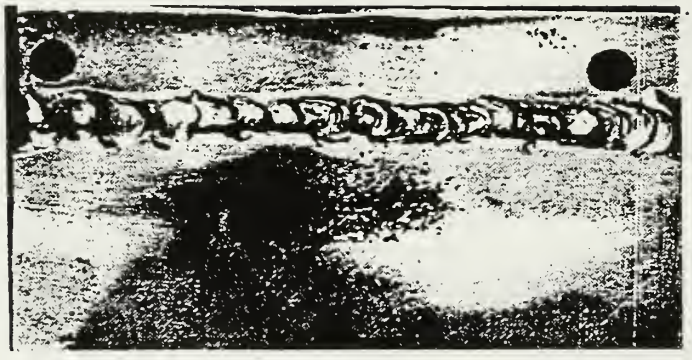
	N/A	Possible	Actual
A. Trade/Occupation Description – defines the trade or occupation – lists the duties of the worker	☐	10	☐
B. Working Conditions – describes the physical conditions of the workplace – identifies the health risks – describes the amount of travel	☐	10	☐
C. Salary and Benefits – presents current hourly rates and/or salary levels – outlines conditions for receiving employee benefits	☐	5	☐
D. Employment Opportunities – identifies local, national or international needs – provides evidence for advancement or for becoming self-employed	☐	10	☐
E. Qualification and Training Opportunities – identifies post-secondary training institutions – describes entrance requirements – describes type and extent of training required	☐	10	☐
F. Additional Information – provides additional sources of information – identifies related occupations	☐	5	☐
Total	☐	50	☐

EXEMPLAR: 6.1

WELD TYPE: **LAP JOINT, FILLET WELD Flat position**

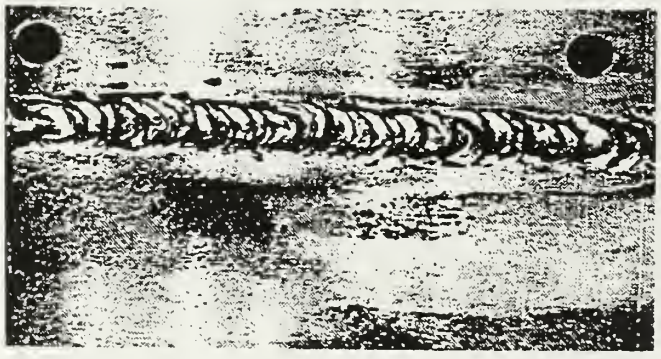
MATERIALS: **_____ mild steel**

PROCESS: **Oxyacetylene Welding**



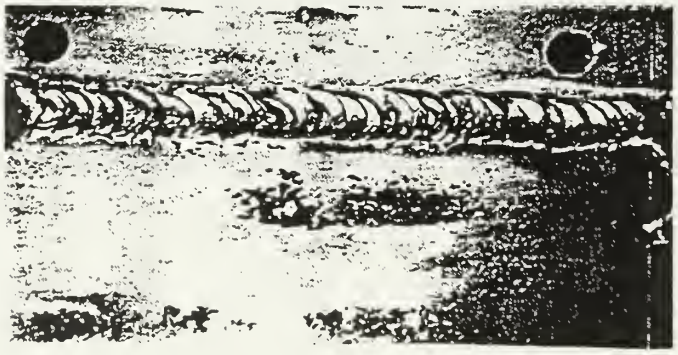
UNACCEPTABLE

Evidence of irregularities and undercutting. Build-up in uneven width of bead varies.



ACCEPTABLE

Beads are slightly convex and generally uniform. Ripples are close and bullet shaped, generally free of voids and evidence of undercutting and overlapping.



OUTSTANDING

Beads are slightly convex and of uniform width and height. Ripples are close, bullet shaped and free of voids and evidence of undercutting and overlapping.

LINKAGES/TRANSITIONS

LINKAGES

With Basic Competencies

The Fabrication Studies strand supports the development and integration of the basic competencies related to personal management and social interactions throughout the introductory, intermediate and advanced modules. It is important that students develop these competencies because success in the workplace often depends more on these skills than technical or academic ones.

Within CTS

Fabrication Studies complements modules from a number of other strands, e.g., Agriculture, Construction Technologies, Design Studies, Energy and Mines, and Enterprise and Innovation.

Note also that project modules from the Career Transitions strand may be combined with modules from the Fabrication Studies strand to provide increased opportunity for students to develop expertise and refine their competencies.

For example, a fabrication project may require more time than the 25 hours that is available in the module. In this case, project modules from the Career Transitions strand may be accessed to complete the task successfully.

Project modules could also be used along with other modules such as:

- Exploring Production Systems
- Structural Design and Engineering
- Custom Fabrication
- Material Testing
- Prefabrication Principles

to allow for greater flexibility and time to develop competencies in these areas.

Other specific linkages include:

Strand	Module	Linkages
Agriculture	Agriculture Processing I	construction of structures used in processing and storage of agriculture products, livestock and equipment
Construction Technologies	Climate Control Systems	links with the sheet metal fabrication modules
	Plumbing Systems	links with Pipe Fitting
Design Studies	Sketching, Drawing and Modelling—Fundamentals	can be offered in conjunction with the Structural Design and Engineering module
	Technical Drawing Application	used in the context of Print Reading
Energy and Mines	Refining Rocks and Minerals	provides a good background for metallurgy
Enterprise and Innovation	Planning a Venture	used with the fabrication and production modules

Other more general linkages apply to Information Processing, Financial Management, Management and Marketing and Communication Technology.

With Elementary Programs

The development of concepts related to Fabrication Studies can begin as early as ECS using hand tool activities and teaching strategies similar to those outlined in the Integrated Practical Activities for elementary grades (1980).

With Secondary Programs

For learning to be authentic, it is important to integrate the core and complementary areas with Fabrication Studies. Being aware of and supporting the content of other curricula promotes relevance and reinforces core and complementary concepts.

Specific examples of linkages between core and complementary programs include:

Subject	Linkage
Language Arts	Technical report writing, task analysis, event scheduling and oral and multi-media presentations
Mathematics	Measurement, calculation of linear area and volume measurements, use of fractions, ratios, geometry and trigonometry
Science	Material properties, structures, chemistry, safety, use of simple machines and electricity and environmental concerns
Social Studies	Economics, impact of technology on society, resource development and industrial relationships
CALM	Career assessment and preparation
Art	Metal sculpture and casting
Drama	Stage prop fabrication

TRANSITIONS

To the Workplace

Competencies developed in Fabrication Studies provide students with many of the entry level skills required in the workplace.

The National Occupation Classification (NOC) and Provincial Occupation Profiles (POP), shown in chart form in this section, indicate occupations for which Fabrication Studies provides a foundation. According to this chart, high school students could potentially move into twelve occupations requiring high school education and nine trades related to Fabrication Studies.

TO RELATED POST-SECONDARY PROGRAMS

The themes and modules offered in Fabrication Studies are consistent with many of the pre-employment and apprenticeship courses now being offered by post-secondary institutions.

While there is no formal agreement to give special consideration to students with a Fabrication Studies background, students may receive advanced placement or be able to challenge portions of the program.

Students are encouraged to compile and present a portfolio whenever they are applying to a post-secondary institution.

Apprenticeship articulation, particularly at the first period level should also be possible, depending on the recommendations of the employer, for students who have gained sufficient background in a specific trade area such as welding. Refer to the charts in this section to see the relationship of the Fabrication Studies modules to a number of common trades and occupations.

POTENTIAL OPPORTUNITIES FOR TRANSITION INTO THE WORKPLACE/POST SECONDARY PROGRAMS

Occupational Profile	NOC/POP	A	B	C	D
Blacksmiths and Die Setters	NOC	✓			
Boiler Maker	NOC	T/✓			
Contractors and Supervisors, Metal forming, Shaping and Erecting Occupations	NOC	T/✓			
Forging Machine Operators	NOC	✓			
Industrial Engineering and Manufacturing Technologists and Technicians	NOC			✓	✓
Ironworkers	BOTH		T/✓		
Labourers in Metal Fabrication	NOC	✓			
Labourers in Rubber and Plastic Products Manufacturing	NOC	✓			
Materials Engineering Technologists	POP			✓	✓
Metalworking Machine Operators	NOC	✓			
Other Metal Products Machine Operators	NOC	✓			
Other Trades Helpers and Labourers	NOC	✓			
Plastics Processing Machine Operators	NOC	✓			
Plastic Products Assemblers, Finishers and Inspectors	NOC	✓			
Rubber processing Machine Operators and Related Workers	NOC	✓			
Sheet Metal Workers	BOTH		T/✓		
Sprinkler Systems Installer	POP		T/✓		
Steamfitter–Pipefitter	POP		T/✓		
Structural Metal and Platework Fabricators and Fitters	BOTH		T/✓		
Supervisors, Plastic and Rubber Products Manufacturing	NOC	✓			
Tool and Die Maker	POP		T/✓		
Welder	BOTH		T/✓		
Welding, Brazing and soldering Machine Operators	NOC	✓			

The above chart indicates both the National Occupational Classification (NOC) and the Provincial Occupational Profiles (POP) that require:

A: High School Education
B: Apprenticeship
C: College or Vocational Education
D: University

FABRICATION STUDIES

Linkages with Related Post-Secondary Programs *

	PUBLIC COLLEGES												APPRENTICESHIP TRADE	PRIVATE COLLEGES				TECH. INST.			UNIVERSITIES				VOCATION. COLLEGES		
	Alberta College of Art	Fairview College	Grane Prairie Regional College	fv	Keyano College	Lakeland College	Lethbridge Community College	Medicine Hat College	Mount Royal College	Olds College	Red Deer College		Augustana University College	Canadian Union College	Concordia College	King's College, The	Northern Alberta Institute of Technology	Southern Alberta Institute of Technology	Banff Centre	Athabasca University	University of Alberta	Universisity of Calgary	University of Lethbridge	AVC - Lac La Biche	AVC - Lesser Slave Lake	AVC - Calgary
AGRICULTURE AND RELATED STUDIES																										
Farrier Science		C								C																
ARTS - FINE AND APPLIED																										
Arts (including Ceramics, Drawing, Glass, Jewellery, Metals)	D 4y		CD 2t	D	CD 2t			2t	1t		D 2t		B	V					V		BM	BM	BM			
AVIATION																										
Aeronautical/Mechanical Engineering Technology																		CD 3y								
Aircraft Maintenance Engineering/Engineers Technology																	V	VD								
ENGINEERING AND RELATED TECHNOLOGIES																										
Civil Engineering Technologies (including Building Construction, and Surveying and Mapping)							D										D	D							C	
Engineering (including degree programs in Agricultural, Chemical, Civil, Computer, Electrical, Engineering Physics, Mechanical, Metallurgical, Mining, Petroleum, and Survey			1t		1t			1t	1t		1t			1t	1t						BM Phd	DBM Phd	1t			

CODES:

B	Bachelor's Degree	V	Varies
M	Master's Degree	1t	One-year transfer
PhD	Doctoral Degree	2t	Two-year transfer
C	Certificate (1 year or less)	w	weeks
D	Diploma (2 years)	m	months
		y	years

* This chart was adapted from "It's About Time To start thinking about your future" (1993-1994 published by Alberta Advanced Education and Career Development in cooperation with Alberta Education)

Linkages with Related Post-Secondary Programs *

	PUBLIC COLLEGES											APPRENTICESHIP TRADE	PRIVATE COLLEGES				TECH. INST.			UNIVERSITIES				VOCATION. COLLEGES		
	Alberta College of Art	Fairview College	Grande Prairie Regional College	fv	Keyano College	Lakeland College	Lethbridge Community College	Medicine Hat College	Mount Royal College	Olds College	Red Deer College		Augustana University College	Canadian Union College	Concordia College	King's College, The	Northern Alberta Institute of Technology	Southern Alberta Institute of Technology	Banff Centre	Athabasca University	University of Alberta	Universisity of Calgary	University of Lethbridge	AVC - Lac La Biche	AVC - Lesser Slave Lake	AVC - Calgary
INDUSTRIAL TRADES AND TRAINING																										
Construction Trades:																										
Heavy Equipment/Industrial Operations (including Crane and Hoisting Equipment Operator, Crawler Tractor, Front End Loader, Hydraulic Backhoe Excavating, Motor Grader/Scraper)					C 5w							1y 2y 3y														
Sheet Metal Worker												4y														
Mechanical Trades																										
Boiler Maker												3y														
Heavy Equipment Technician (including Diesel Mechanics, Industrial Heavy Equipment Technicians/Technology, Journeyman Updating and Pre-employment		V C				V	C				30w	4y					C D	C								
Iron Worker												3y														
Machinist												4y					C	C								
Millwright (including Pre-employment and Upgrading			C 16w									4y					V C									

CODES:

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		y	years

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FABRICATION STUDIES

Linkages with Related Post-Secondary Programs *

	PUBLIC COLLEGES												APPRENTICESHIP TRADE	PRIVATE COLLEGES				TECH. INST.			UNIVERSITIES				VOCATION. COLLEGES		
	Alberta College of Art	Fairview College	Grane Prairie Regional College	fv	Keyano College	Lakeland College	Lethbridge Community College	Medicine Hat College	Mount Royal College	Olds College	Red Deer College			Augustana University College	Canadian Union College	Concordia College	King's College, The	Northern Alberta Institute of Technology	Southern Alberta Institute of Technology	Banff Centre	Athabasca University	University of Alberta	Universisity of Calgary	University of Lethbridge	AVC - Lac La Biche	AVC - Lesser Slave Lake	AVC - Calgary
Automotive Service Technician (including Automoitives/Automotie Service Technology, Gasoline Engine Performance Analysis, and Pre-employment		C 24w				C 12w	D	12w			D		4y					C	VD						C 16w	C 32w		
Recreation Vehicle Mechanic													3y															
Structural Steel and Plate Fitter													3y															
Welder (including First Class to A & B Pressure, Pre-employment, upgading to Journeyman)		V	C		C	C 12w		12w			15w		3y					V C D	D						C 22w	C 14w	V	
Pipe Trades																												
Gas Fitter													3y															
Plumber (including Pre-employment)													4y															
Sprinkler System Installer													4y															
Steam Fitter (including Upgrading)													4y					V										

CODES:

B	Bachelor's Degree	V	Varies
M	Master's Degree	1t	One-year transfer
PhD	Doctoral Degree	2t	Two-year transfer
C	Certificate (1 year or less)	w	weeks
D	Diploma (2 years)	m	months
		y	years

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FABRICATION STUDIES MODULE RELATIONSHIP TO SPECIFIC TRADES AND OCCUPATIONS

TRADES AND OCCUPATIONS	Introduction to Construction and Fabrication	Oxyacetylene Welding	Basic Electric Welding	Bar and Tubular Fabrication	Sheet Stock Fabrication	Fabrication Principles	Foundry I	Principles of Machining	Exploring Production Systems	Structural Design and Engineering	Print Reading	Oxyfuel Welding	Thermal Cutting	Shielded Metal Arc - Welding I	Shielded Metal Arc - Welding II	Gas Metal Arc Welding I	Pipe Fitting	Sheet Metal Fabrication I	Sheet Metal Fabrication II	Forging Fundamentals	Foundry II	Precision Lathe Work	Precision Milling	Computer Numerical Controlled Turning	Custom Fabrication	Material Testing	Metallurgy and Heat Treating	Gas Tungsten Arc Welding	Specialized Welding	Shielded Metal Arc Welding III	Shielded Metal Arc Welding IV	Gas Metal Arc Welding II	Pipe Welding	Automated Processes	Cylindrical and Conical Sheet Fabrication	Duct Components	Foundry III	Advanced Lathe Work	Advanced Milling	Computer Numerical Controlled Milling	PreFabrication Principles
Agricultural Mechanic	x	x	x			x		x				x	x	x	x	x	x					x	x				x		x			x					x	x		
Autobody Technician	x	x	x		x	x						x	x			x	x																							
Blacksmith and Die Setters	x			x		x	x		x		x	x	x							x					x														
Boilermaker	x					x					x	x	x	x	x										x														
Farrier	x					x														x					x														
Forging Machine Operators	x					x					x									x							x												
Ind. Eng. and Manufacturing Tech.	x					x		x	x		x											x	x	x	x									x					
Iron Worker	x	x	x	x		x				x	x									x																			x
Machinist	x					x	x	x	x		x										x	x	x	x	x	x	x												
Millwright	x	x	x	x	x	x		x			x	x	x	x	x	x	x			x	x	x	x				x			x	x	x				x			
Automotive Service Technician	x	x				x		x														x	x				x												
Materials Engineering Technologist	x	x	x	x	x	x	x	x	x	x	x									x	x					x	x												
Metalworking Machine Operators	x					x			x		x																x												
Sheet Metal Worker	x	x	x		x	x			x	x	x	x	x					x	x						x		x		x						x			x	
Sprinkler Systems Installer	x			x		x					x														x													x	
Steamfitter - Pipe Fitter	x	x	x	x		x					x	x		x											x		x							x					x	
Structural Steel and Plate Fitter	x	x	x			x				x	x		x	x	x										x		x												
Tool and Die Maker	x					x	x	x	x		x									x	x	x	x	x	x	x	x										x	x	x	
Welder	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x					x	x	x	x	x	x	x	x	x						x
Plumbing	x			x		x					x	x													x		x												
Gas Fitting	x	x	x			x					x	x		x	x										x		x						x						
Refridgeration/Air Conditioning	x				x	x					x							x	x						x									x	x				

CAREER & TECHNOLOGY STUDIES

FABRICATION STUDIES

LEARNING RESOURCE GUIDE

INTERIM 1995
(SEPTEMBER 1995 - SEPTEMBER 1997)

Alberta
EDUCATION

MAY 1995

CURRICULUM STANDARDS BRANCH

Comments and suggestions are welcome and should be directed to:

Career and Technology Studies Unit
Alberta Education
Curriculum Standards Branch
11160 Jasper Avenue
Edmonton, AB
T5K 0L2
Telephone: 422-4872
Fax: 422-5129

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INTRODUCTION

CTS AND THE RESOURCE-BASED CLASSROOM

Career and Technology Studies (CTS) encourages teachers to establish a resource-based classroom, where a variety of appropriate, up-to-date print and non-print resources are available. Learning resources identified for CTS strands include print, software, interactive videos, manipulatives, student learning guides and tutorials.

The resource-based classroom approach accommodates a variety of instructional strategies and teaching styles, and supports individual or small group planning. It provides students with opportunities to interact with a wide range of information sources in a variety of learning situations. Students in CTS are encouraged to take an active role in managing their own learning. Ready access to a strong resource base enables students to learn to screen and use information appropriately, to solve problems, to meet specific classroom and learning needs, and to develop competency in reading, writing, speaking, listening and viewing.

PURPOSE AND ORGANIZATION OF THIS DOCUMENT

The purpose of this document is to help teachers identify a variety of resources to meet their needs and those of the students taking the new Fabrication Studies curriculum. It is hoped that this practical guide to resources will help teachers develop a useful, accessible resource centre that will encourage students to become independent, creative thinkers.

This document is organized as follows:

- Authorized Resources:
  - basic learning resources
  - support learning resources
  - teaching resources
- Other Resources
- Additional Sources.

Some resources in the guide have been authorized for use in some or all of the CTS strands, e.g., the 11-video Career and Technology Studies series produced by ACCESS Network. Full information is provided in the appropriate section of this resource guide.

Each resource in the guide provides bibliographic information, an annotation where appropriate, and a correlation to the Fabrication Studies modules. The distributor code for each entry will facilitate ordering resources. It is recommended that teachers preview all resources before purchasing, or purchase one copy for their reference and additional copies as required.

Distributor Code	Resources		Levels/Mod. No.		
			1	2	3
ATEC	Author	Title	101	201	301
	Bibliographic Information				
	Annotation				

1 = Introductory
2 = Intermediate
3 = Advanced

Indicates module number

Distributor Code - see Distributor Directory

HOW TO ORDER

Most authorized resources are available from the Learning Resources Distributing Centre (LRDC) at:

12360 - 142 Street
Edmonton, AB
T5L 4X9
Telephone: 427-2767
Fax: 422-9750

Purchase order numbers have been provided (where possible) for resources available through the LRDC. The section on Additional Sources lists a variety of other places to find information related to this strand. In addition, at the back of this document is a Distributor Directory, which contains the name and address of each publisher/distributor referred to in the resource list. Note that in some cases a resource may be published by one company but distributed through another.

The information contained is as complete and accurate as possible.

RESOURCE POLICY

For further information on resource policy and definitions, refer to the *Student Learning Resources Policy* and *Teaching Resources Policy* or contact:

Learning Resources Unit
Curriculum Standards Branch
Alberta Education
5th Floor, Devonian Building, East Tower
11160 Jasper Avenue
Edmonton, AB
T5K 0L2
Telephone: 422-4872
Fax: 422-5129

AUTHORIZED RESOURCES

BASIC LEARNING RESOURCES

The following basic learning resources have been authorized by Alberta Education for use in the Fabrication Studies curriculum. A curriculum correlation appears in the right-hand column.

Distributor Code	Resources	Levels/Module No.		
		1	2	3
LRDC	*Design and Technology.* Colin Caborn, et al. Scarborough, ON: Nelson Canada,1989. Student Text. Adopts an integrated approach that links design with technology. Content includes information and activities related to materials, tools, structures, mechanism and micro electronics.	101 111 109 110 112 113	201 211 212	
LRDC	*Metalwork Technology and Practice.* (9th Edition.) Victor E. Repp. Peoria, IL: Glencoe Division, Macmillan/McGraw-Hill, 1994. Student Text. Provides a comprehensive introduction to metal fabrication technologies. This resource can be used for introductory, intermediate and advanced level activities related to metal fabrication and product manufacturing. Measurements are given in Imperial followed by their S.I. Metric equivalents. The Instructor's Resource Guide includes teaching strategies answers to review question, projects and overhead masters. A student workbook is also available.	101 104 105 111 109 110 112 113 116	202 203 204 205 206 207 217 209 210 211 212 213 214 215 216	301 302 305 306 317 310 312 313 314 315
LRDC	*Modern Welding. Complete coverage of the welding field in one easy-to-use volume.* Andrew D. Althouse, et al. South Holland, IL: Goodheart-Willcox Co., Inc. 1992. Student Text. Covers the theory, fundamentals and basic processes along with the practical applications that build skills and techniques for the student welder. Most measurements are provided in both Imperial and S.I. Metric equivalents. Terms used are those recommended by the American Welding Society. A Lboratory Manual for students and Instructor's Guide for Teachers is also available.	104 105	202 203 204 205 206 207	301 302 303 304 305 306 317 307 308
LRDC	*Technology Shaping Our World.* John Gradwell, et al. South Holland, IL: Goodheart-Willcox Co., Inc., 1993. Student Text. Introduces students to modern technology. Organizes learning so that students progress from planning, designing, communicating to applied activities within a technological system. An Instructor's Manual for teachers outlines many methods of presenting the concepts in the text to students.	101 111 109 110	201 202	

SUPPORT LEARNING RESOURCES

Support learning resources are authorized by Alberta Education to assist in addressing some of the learner expectations of a module or components of modules.

Distributor Code	Resources	Levels/Module No.		
		1	2	3
LRDC	*Basic Arc Welding.* (SMAW). (4th Edition.) Ivan H. Griffin, et al. Albany, NY: Delmar Publishers Inc., 1984. Student Text. Teaches the basic skills of shielded metal arc welding with step-by-step instructions for completing a variety of welds. An Instructor's Guide is also available.	105	205 206	305 306
LRDC	*Basic Blueprint Reading and Sketching.* Thomas P. Olivo, et al. Albany, NY: Delmar Publishers Inc., 1993. Combined Student Text and Workbook. This edition is based on an occupational analysis of conventional drafting room practices in relation to ANSI and S.I. Metric standards. Covers machine and welding drawing as well as CAD and robotic applications.	104 105 111 113	202 205 206 217 213 214 215	303 305 306 317 307 308 313 314 315
LRDC	*Basic Oxyacetylene Welding.* (4th Edition.) Ivan H. Griffin, et al. Albany, NY: Delmar Publishers Inc., 1984. Student Text. Teaches the basic skills of oxyacetylene welding, cutting, braze welding, silver soldering with step-by-step instructions. An Instructor's Guide is also available.	104 110	203 204	
LRDC	*Basic Tig and Mig Welding (GTAW & GMAW).* (3rd Edition.) Ivan H. Griffin, et al. Albany, NY: Delmar Publishers Inc., 1984. Emphasizes basic skill development in "TIG" and "MIG" welding. Covers the use of equipment, variables, safety, data for welding metals and welding procedures with step-by-step instructions.	105	207	303 317
ACC	*Career and Technology Studies: Key Concepts.* Edmonton, AB: ACCESS Network. Series of videos and utilization guides relevant to all CTS strands. Series consists of *Anatomy of a Plan, Creativity, Electronic Communication, The Ethics Jungle, Go Figure, Innovation, Making Ethical Decisions, Portfolios, Professionalism, Project Planning, Responsibility* and *Technical Writing.*	all	all	all
LRDC	*Computer Numerical Control Simplified.* Mike Fitzpatrick. Columbus, OH: Glencoe. 1992. Student Text. Based on current industrial practice and written for the beginning student. Hands-on activities throughout help prepare the student to become entry-level CNC operators.	113	202 215	308 315

Support Learning Resources (Cont'd.)

Distributor Code	Resources	Levels/Module No.		
		1	2	3
LRDC	*Design and Technology.* Kathy Browning, et al. Toronto, ON: McGraw-Hill Ryerson Ltd., 1933. Student Text. Explores structures, energy, machines, materials and fabrication processes with an emphasis on designing, decision making and problem solving. A Teacher's Resource Guide is also available.	101 111 109 110 113	201	
LRDC	*Gas Metal Arc Welding Handbook.* William H. Minnick. South Holland, IL: Goodheart-Willcox Co., Inc., 1991. Student Text. Provides a simple but complete introduction to gas metal arc welding. The text is organized to lead the student in a step-by-step fashion through the principles and practices of GMAW. Includes section on auto body welding. *Instructor's Guide for use with Gas Metal Arc Welding* is also available. A Combined Instructor's Guide and answer key is also available.	105 111 110	207 217 210 216	304 307 308 310 316
LRDC	*Gas Tungsten Arc Welding Handbook.* William H. Minnick. South Holland, IL: Goodheart-Willcox Co., Inc., 1992. Student Text. Provides a comprehensive coverage of the theory, fundamentals, equipment and safety issues related to GTAW. Includes section on semi-automatic and automatic welding processes. *Instructor's Guide for use with Gas Tungsten Arc Welding handbook* is also available. A combined Instructor's Guide and Answer Key is also available.			301 303 304 308 316
LRDC	*Living with Technology.* (2nd edition.) Michael Hacker, et al. Albany, NY: Delmar Publishers Inc., 1993. Student Text. Uses a "cluster" framework to analyze the major areas of technology: manufacturing, construction, communications, energy, power and transportation. The teacher's resource guide includes lesson plans, teaching strategies, quizzes and instructional aides for each chapter. Uses Imperial measurements only.	101 109 110 116	201	
LRDC	*Manufacturing Systems.* R. Thomas Wright. South Holland, IL: Goodheart-Willcox Co., Inc. 1990. Student Text. Covers the basic elements of manufacturing as a managed body of activities related to material processing and the management of people and other resources. This resource also provides information on how to form a company to design, produce and market a product. A Sudent Activity Manual andTeacher's Resource Guide are also available.	101 108 111 112 116	209 211 215 216	302 309 315 316

Support Learning Resources (Cont'd.)

Distror Code	Resources	Levels/Module No.		
		1	2	3
LRDC	*Metallurgy Fundamentals.* Daniel A. Brandt. South Holland, IL: Goodheart-Willcox Co. Inc. 1992. Student Text. Provides instruction and information on the basic principles of metallurgy by emphasizing the practical aspects of this field of study. Photographs and drawings are used to help the reader understand this complex topic. A combined Instructor's Guide and Answer Key is also available.	101 110 112	203 204 205 206 207 211 212	301 302 303 304 305 306 317 307
LRDC	*Metalwork Technology and Practice.* (9th edition.) Victor E. Repp. Peoria, IL: Glencoe Division, MacMillan/McGraw-Hill, 1994. Student Workbook. See Basic Learning Resources for module correlation and annotation.			
LRDC	*Modern Welding, Laboratory Manual for.* Andrew D. Althouse et al. South Holland, IL: Goodheart-Willcox Co. Inc. 1992. Laboratory Manual. See Basic Learning Resources for Module correlation and annotation.			
LRDC	*Modern Metalworking.* John R. Walker. South Holland, IL: Goodheart-Willcox Co. Inc. 1993. Student Text and Workbook. Emphasizes the important place metals occupy in our everyday lives and explores the numerous metalworking career opportunities. This resource is designed to provide a broad experience in metalworking through the use of tools, machines and materials that are basic to this field. An Instructor's Guide contains answers to the Workbook and Text questions.	101 103 105 111 109 110 112 113	202 209 210 211 212 213 214	301 302 308 309 312 313 314
LRDC	*Modern Plumbing.* E. Keith Blankenbaker. South Holland, IL: Goodheart-Willcox Co. Inc. 1992. Student Text. Provides basic information about the tools, materials, equipment, processes and career opportunities in the plumbing field. This edition includes the latest installation techniques and recent developments in materials, fixtures and appliances.	111 110	217	
LRDC	*Modular Courses in Technology: Structures.* Alan Blundell, et al. Edinburgh: Oliver and Boyd, a Division of Longman Group UK Ltd., 1992. Student Text. Covers many of the factors that engineers have to consider when faced with a structural design problem. Besides the forces imposed on a structure and the materials from which it is made, the resource also deals with the appearance and the effect the structure will have on the environment.	101	201	301

Support Learning Resources (Cont'd.)

Distributor Code	Resources	Levels/Module No.		
LRDC	*Pipe Welding Techniques.* (4th edition.) Ivan H. Griffin, et al. Albany, NY: 1985. Student Text. Emphasizes the latest techniques in pipe welding in addition to units on welding codes, weld testing and pipe fitting, GTAW, GMAW and FCAW processes are covered in relation to pipe welding. Instructor's Guide is also available.		204 217	301 303 304 305 306 317 307 308
LRDC	*Production Technology.* Stanley A. Komacek. Albany, NY: Delmar Publishers Inc., 1993. Student Text. Offers a broad exploration of the tools, materials and processes of production. Demonstrates how production technology affects and is affected by science and math.	101 111 109 113 116	201 216	
LRDC	*Structures With Materials, GCSE Technology.* Cheltenham, England: Steve Rich, Stanley Thornes (Publishers) Ltd., 1991. Student Text. Applies a problem-solving approach to the "harder" end of technology. Activities are designed for both individual and group settings. Teachers should be aware that a potential community concern may exist regarding the topic of evolution (page 32).	101 111 109 110 116	201 216	316
LRDC	*Welding Technology Fundamentals.* William A. Bowditch, et al. South Holland, IL: Goodheart-Willcox Co. Inc. 1991. Student Text and Laboratory Manual. Covers the equipment and techniques for the welding and cutting processes most often used in industry today. This resource contains information about welding careers and the physics of welding. Weld inspection and testing, drawing interpretation and welding symbols are also covered in a manner that can be understood by the secondary student.	104 105	202 203 204 205 206 207	301 302 303 304 304 306 317

TEACHING RESOURCES

The following teaching resources are authorized by Alberta Education to assist teachers in the instructional process.

Distributor Code	Resources	Levels/Module No.		
		1	2	3
LRDC	*Basic Arc Welding (SMAW) (4th Edition), Instructor's Guide.* Ivan H. Griffin, et al. Albany, NY: Delmar Publishers Inc. 1984. See Support Learning Resources for module correlation and annotation.			
LRDC	*Basic Oxyacetylene Welding (4th Edition), Instructor's Guide.* Ivan H. Griffin, et al. Albany, NY: Delmar Publishers Inc. 1984. See Support Learning Resources for module correlation and annotation.			
LRDC	*Complete Handbook of Sand Casting, The: A do-it-yourself guide to forming all types of metal in versatile sand molds.* (Revised Edition.) C. W. Ammen. Blue Ridge Summit, PA: TAB Books, 1979. Text. This detailed handbook describes basic principles of foundry types and kinds of sand to use for various types of castings, the tools of the trade, how to make patterns and cores, build molds, pour metals and recognize casting.	112	212	312
LRDC	*Complete Metalsmith, The.* Tim McCreight. Worcester, MA.: Davis Publications, Inc. 1991. Text. Provides an extensive coverage of topics related to metalsmithing. Topics are arranged according to the process involved and deal with simple through to the complex in each chapter.	101 109 110 112	212	312
LRDC	*Gas Metal Arc Welding Handbook, Instructor's Guide and Answer Key.* William H. Minnick. South Holland, IL: Goodheart-Willcox Co. Inc. 1988. See Support Learning Resources for module correlation and annotation.			
LRDC	*Gas Tungsten Arc Welding Handbook, Instructor's Guide.* William H. Minnick. South Holland, IL: Goodheart-Willcox Co. Inc. 1992. See Support Learning Resources for module correlation and annotation.			

Teaching Resources (Cont'd.)

Distributor Code	Resources	Levels/Module No.		
		1	2	3
LRDC	*Design and Technolog, Teacher's Resource.* Kathy Browning. Toronto, ON: McGraw-Hill Ryerson Ltd., 1993. See Support Learning Resources for module correlation and annotation.			
LRDC	*Manufacturing Systems, Teacher's Resource Guide.* R. Thomas Wright. South Holland, IL: Goodheart-Willcox Co., Inc. 1990. See Support Learning Resources for module correlation and annotation.			
LRDC	*Modern Metalworking, Instructor's Guide.* John R. Walker. South Holland, IL: Goodheart-Willcox, Inc. 1993. See Support Learning Resources for module correlation and annotation.			
LRDC	*Modern Welding, Instructor's Guide.* Andrew D. Althouse. South Holland, IL: Goodheart-Willcox Co. Ltd. 1986. See Basic Learning Resources for module correlation and annotation.			
LRDC	*Pipe Welding Techniques (4th Edition), Instructor's Guide.* Ivan H. Griffin, et al., Albany, NY: Delmar Publishers Inc. 1985. See Support Learning Resources for module correlation and annotation.			
LRDC	*Sheet Metal Hand Processes.* Claude J. Zinngrable, et al. Albany, NY: Delmar Publishers Inc. 1974. Combined Student Text and Workbook. Introduces the beginning sheet metal technician to basic instruction in the proper selection of metal and fabrication processor.	101 109	209 210	310 311
LRDC	*Sheet Metal Machine Processes.* Claude J. Zinngrable, et al. Albany, NY: Delmar Publishers Inc. 1974. Combined Student Text and Workbook. Explains the procedures used on hand- and power-operated sheet metal machine tools in a step-by-step fashion.	109	209 210	310 311
LRDC	*Technology Shaping our World. Instructor's Manual.* John Gradwell. South Holland, IL: Goodheart-Willcox Co. Inc. 1993. See Basic Learning Resources for module correlation and annotation.			

Teaching Resources (Cont'd.)

Distributor Code	Resources	Levels/Module No.		
		1	2	3
NAIT	*Welding for Apprentices, 1st Year.* Northern Alberta Institute of Technology. Edmonton, AB: Alberta Advanced Education and Career Development. Developed by the Technical Institutes and Colleges of Alberta to meet the needs of first-year welding apprentices. Covers oxyacetylene welding and cutting, as well as Shielded Metal and Gas Metal Arc Welding.	104 105	203 204 205 206 207	305 306 317
LRDC	*Welding Principles and Applications. (3rd Edition.)* Larry Jeffus. Albany, NY: Delmar Publishers Inc., 1993. Student Text. Comprehensive resource that provides the basis for welding through an in-depth explanation of the operation of welding equipment supplies. This resource also discusses occupational opportunities in welding and explains the training required for certain welding occupations.	104 105	202 203 204 205 206 207	301 302 303 304 305 306 317 307 308
MLC & NAIT	*Welding Safety.* Northern Alberta Institute of Technology. Oakville, ON. Magic Lantern Communications Ltd., 1986. Video and Reference Guide. Designed to cover welding safety in relation to protective clothing, safety equipment and safe work practices. The Reference Guide enhances and reinforces the material presented in the videotape and can serve as a personal reference manual.	104 105	202 203 204 205 206 207	302 303 304 305 306 317 307 308
LRDC	*Welding Technology Fundamentals, Answer Key.* William A. Bowditch. South Holland, IL: Goodheart-Willcox Co. Ltd. 1991. See Support Learning Resources for module correlation and annotation.			

FABRICATION STUDIES: RESOURCE AND MODULE CORRELATION

THEME CODE:
A. Materials and Structures
B. Fabrication Processes
C. Production Systems and Processes

FORMAT CODE:
P - Print
V - Video
S - Software

STATUS CODE:
B - Basic
S - Support
T - Teaching

LEVEL CODE:
1 - Introductory
2 - Intermediate
3 - Advanced

| | | |

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T - Teaching

LEVEL CODE:
1 - Introductory
2 - Intermediate
3 - Advanced

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FABRICATION STUDIES: RESOURCE AND MODULE CORRELATION

THEME CODE:
A. Materials and Structures
B. Fabrication Processes
C. Production Systems and Processes

FORMAT CODE:
P - Print
V - Video
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OTHER RESOURCES

These titles are provided as a service only to assist local jurisdictions to identify resources that contain potentially useful ideas for teachers. Alberta Education has done a preliminary review of the resources. However, the responsibility to evaluate these resources prior to selection rests with the user, in accordance with any existing policy.

Distributor Code	Other Resources
AECD	*Apprenticeship Training, Machinist Program.* Edmonton, AB: Alberta Advanced Education and Career Development. Outlines the parameters for apprenticeship and course requirements for each period of the machinist program.
AECD	*Apprenticeship Training, Sheet Metal Worker Program.* Edmonton, AB: Alberta Advanced Education and Career Development. Outlines the parameters for apprenticeship and course requirements for each period of the sheet metal program.
AECD	*Apprenticeship Training, Steamfitter - Pipefitter Program.* Edmonton, AB: Alberta Advanced Education and Career Development. Outlines the parameters for apprenticeship and course requirements for each period of the steam and pipefitter program.
AECD	*Apprenticeship Training, Welder Program.* Edmonton, AB: Alberta Advanced Education and Career Development. Outlines the parameters for apprenticeship and course requirements for each period of the welder program.
LEC	*Learn to Weld - The Lincoln Way.* Cleveland, OH: The Lincoln Electric Company. Book Division Video. This tape concentrates on the fundamental techniques of horizontal, vertical and overhead welding. Safety section and technical welding guides included.
WIC	*"MIG" Welding, mild steel with low current sets.* (Video Guide), Video, 54 minutes. The Welding Institute of Canada, Oakville, ON. Shows how to use a low current Metal Arc Welding equipment to achieve professional results.

OTHER RESOURCES (Cont'd.)

Distributor Code	Other Resources
WIC	*Manual Metal Arc (Stick) Welding, Mild Steel with Low Power Sets.* Oakville, ON: The Welding Institute of Canada. Video, 50 minutes. Shows how to use low power Shielded Metal Arc Welding equipment to achieve professional results.
CIE	*Manufacturing: Material Testing I & II.* Department of Industry and Technology, Ball State University, Muncie, IN: Center for Implementing Education, 1986. This series contains 20 low-cost teacher-developed material-testing activities that can be carried out in a typical materials facility.
AL	*Occupational Health and Safety Act.* Edmonton, AB: Alberta Labour.
AECD	*Provincial Occupational Profiles.* Edmonton, AB: Alberta Advanced Education and Career Development. Provides up-to-date information on trades and occupations related to the fabrication sector.
AL	*WHMIS: An Introduction.* Edmonton, AB: Alberta Labour. Pocket size booklet that outlines the purpose of WHMIS, methods used to classify and label materials, material safety, data sheets and worker education.

ADDITIONAL SOURCES

Available to Fabrication Studies teachers, both locally and provincially, are many sources of information that can be used to enhance Career and Technology Studies. These sources are available through the community, government agencies, resource centres and organizations. Some of these sources, e.g., government departments undergo frequent name and/or telephone number changes. Please consult your telephone directory or an appropriate government directory.

The following is a partial list of sources in the community to consider:

TEACHER-LIBRARIANS

Planned and purposeful use of library resources helps students grow in their ability to gather, process and share information. Research activities require access to an adequate quantity and variety of appropriate, up-to-date print and non-print resources from the school library, other libraries, the community and additional sources. Some techniques to consider are:

- planning together
- establishing specific objectives
- integrating research skills into planning.

Coopèration between the teacher-librarian and the subject area teacher in the development of effectively planned resource-based research activities ensures that students are taught the research skills as well as the subject content.

Also see *Focus on Research: A Guide to Developing Student's Research Skills* referenced in the Alberta Education Resources section.

ALBERTA EDUCATION SOURCES

The following monographs are available for purchase from:

Learning Resources Distributing Centre
12360 - 142 Street
Edmonton, AB
T5L 4X9
Telephone: 427-2767
Fax: 422-9750

Please consult the "Support Documents" section or the "Legal, Service and Information Publications" section in the *Buyers Guide* for ordering information and costs.

Developmental Framework Documents

- *The Emerging Student: Relationships Among the Cognitive, Social and Physical Domains of Development,* 1991

  This document looks at the whole child, or student, as a productive learner, integrating all the domains of development: cognitive, social and physical. It emphasizes the need for providing balanced curriculum and instruction.

- *Students' Interactions Developmental Framework: The Social Sphere,* 1988

  This document focuses on the student as a social being. It looks at the student's affective or emotional growth and examines moral development. These three domains make up the social sphere.

- *Students' Physical Growth: Developmental Framework Physical Dimension,* 1988

  This document examines children's normal physical growth in three areas: perceptual, structural and motor development. In none of these areas is the child's growth in a single continuous curve throughout the first two decades of life. Physical growth is characterized by periods of rapid growth and periods of slower growth. Consequently, differences and changes in growth patterns may affect the timing of certain learning processes.

- *Students' Thinking: Developmental Framework Cognitive Domain,* 1987

  This document explores children's cognitive development from infancy to adolescence. The Piagetian stages of pre-operational, concrete operational and formal operational thinking are explained. Suggestions for improving the learning process are also presented.

Others

- *Focus on Research: A Guide to Developing Students' Research Skills,* 1990

  This document outlines a resource-based research model that helps students manage information efficiently and effectively, and in this process, to gain skills that are transferable to all school and work situations. This model provides a developmental approach to teaching students how to do research.

- *Teaching Thinking: Enhancing Learning,* 1990

  Principles and guidelines for cultivating thinking, ECS to Grade 12, have been developed in this resource. It offers a definition of thinking, describes nine basic principles on which the suggested practices are based, and discusses possible procedures for implementation in schools and classrooms.

OTHER GOVERNMENT SOURCES

ACCESS Network
ACCESS Network offers a variety of resource and services to teachers. For a nominal dubbing and tape fee, teachers may have ACCESS Network audio and video library tapes copied.

ACCESS Network publishes a listing of audio and video cassettes as well as a comprehensive programming schedule. Of particular interest are the Career and Technology Studies videos, which are available with teacher utilization guides. The guides outline key points in each video and suggest questions for discussion, classroom projects and other activities. Video topics are listed in the Support Learning Resources section of this Guide. The videos and accompanying support material can be obtained from:

ACCESS Network
3720 - 76 Avenue
Edmonton, AB
T5B 2N6
Telephone: 440-7777 (in Edmonton)
1-800-352-8293
(outside Edmonton)

Alberta Agriculture
Print Media Branch
7000 - 113 Street
Edmonton, AB
T6H 5T6

Alberta Labour
9940 - 106 Street
Edmonton, AB
T5K 2N2
Telephone: 427-8848
Fax:

Alberta Labour offices are also located in Calgary, Camrose, Edson, Fort McMurray, Grande Prairie, Lethbridge, Medicine Hat, Red Deer, Peace River, and Vermilion.

National Film Board of Canada (NFB)
The NFB has numerous films and videotapes that may be suitable for Fabrication Studies. For a listing of NFB films and videotapes indexted by title, subject and director, or for rental or purchase of NFB films and videotapes, call 1-800-267-7710 (toll-free).

Educational Marketing Officers in Calgary and Edmonton are available, province wide, for workshops, conferences, professional development days and similar activities. For northern Alberta and the Northwest Territories, the Educational Marketing Officer can be reached at 495-3012 (fax, 495-6412). For southern Alberta, contact the Educational Marketing Officer at 292-5411 (fax, 292-5458).

ACCESS Network and some school boards have acquired duplication rights to some NFB videotapes. Please consult the relevant catalogues in your school or school district.

The Calgary Public Library has a selection of NFB films and videotapes that can be borrowed free of charge with a Calgary Public Library borrower's card. For further information, contact:

Calgary Public Library
Films and Recordings Department
616 Macleod Trail SE
Calgary, AB
T2G 2M2
Telephone: 260-2781

Resource Centres

Urban Resource Centres

Calgary Board of Education
Supervisor, Education Media
3610 - 9 Street SE
Calgary, AB
Telephone: 294-8540
Fax: 287-9739

Calgary Separate School Board
Supervisor, Instructional Materials
1000 - 5 Avenue SW
Calgary, AB
T2P 4T9
Telephone: 246-6663
Fax: 249-3054

County of Strathcona
Director, Learning Resource Service
2001 Sherwood Drive
Sherwood Park, AB
T8A 3W7

Edmonton Public School Board
Learning Resource Consultant
Centre for Education
One Kingsway Avenue
Edmonton, AB
T5H 4G9
Telephone: 429-8320
Fax: 429-8313

Lakeland School District No. 5460
Area Superintendent
Postal Bag 1001
6005 - 50 Avenue
Bonnyville, AB
T9N 2L4
Telephone: 826-3145
Fax: 826-4600

Medicine Hat School District No. 75
IMC Manager
601 - 1 Avenue SW
Medicine Hat, AB
T1A 4Y7
Telephone: 526-1323
Fax: 529-5339

Red Deer Public School Board
Coordinator of Instruction
4747 - 53 Street
Red Deer, AB
T4N 2E6
Telephone: 343-1405
Fax: 347-8190

St. Anthony's Teacher Centre
Supervisor, Curricular Resources
10425 - 84 Avenue
Edmonton, AB
T6E 2H3
Telephone: 439-7356
Fax: 433-0181

Regional Resource Centres

Zone 1

Zone 1 Regional Resource Centre
Film Supervisor
10020 - 101 Street
P.O. Box 6536
Peace River, AB
T8S 1S3
Telephone: 624-3187
Fax: 624-5941

Zones II and III

Central Alberta Media Services (CAMS)
Film Supervisor
182 Sioux Road
Sherwood Park, AB
T8A 3K5
Telephone: 464-5540
Fax: 467-5469

Zone IV

Alberta Central Regional Education Services (ACRES)
Operations Manager
County of Lacombe
Parkland Regional Library Building
56 Avenue and 53 Street Corner
Box 3220
Lacombe, AB
T0C 1S0
Telephone: 782-5730
Fax: 782-5831

Zone V

South Central Alberta Resource Centre (SCARC)
c/o County of Wheatland
435 B Hwy #1
Strathmore, AB
T1P 1J4
Telephone: 934-5028
Fax: 934-4889

Zone VI

Southern Alberta Learning Resource Centre (SALRC)
Film Supervisor
Provincial Government Administration Building
120, 909 Third Avenue N
Box 845
Lethbridge, AB
T1J 3Z8
Telephone: 320-7807
Fax: 320-7817

EDUCATIONAL ORGANIZATIONS

American Vocational Association
1410 King Street
Alexandria, VA
22314

Canadian Vocational Association
P.O. Box 3435 Station D
Ottawa, ON
K1P 6L4

International Technology Education Association
1914 Association Drive
Reston, VA
22091

Junior Achievement of Northern Alberta
(Alberta north of Lacombe, and NWT)
161, 10700 - 104 Avenue
Edmonton, AB
T5J 4S2

Junior Achievement of Southern Alberta
(Lacombe and south)
739 - 10 Avenue SW
Calgary, AB
T2R 0B3

Skills Canada Alberta
10035 - 102 Avenue
Edmonton, AB
T5J 0E5
Telephone: 493-2630
Fax: 493-2649

PROFESSIONAL ASSOCIATIONS

Alberta Building Trades Council
201, 11738 Kingsway Avenue
Edmonton, AB
T5G 0X5

Alberta Construction Safety Association
10949 - 120 Street
Edmonton, AB
T5H 3R2

Alberta Society of Engineering Technologist
1520 Royal Trust Tower
Edmonton Centre
Edmonton, AB
T5J 2Z2

Canadian Construction Association
85 Albert Street
Ottawa, ON
K1P 6A4

Canadian Manufacturers Association
101, 130 Albert Street
Ottawa, ON
K1P 5G4

Mechanical Contractors Association of Alberta
204, 2725 - 12 Street NE
Calgary, AB
T2E 7J2

Sheet Metal Workers International Association
Local 8
204, 10544 - 106 Street
Edmonton, AB
T5H 2X6

Welding Institute of Canada
350, 6815 - 8 Street NE
Calgary, AB
T2E 7H7

The Welding Institute of Canada has a selection of resource material suitable for student training and teacher upgrading.

EQUIPMENT MANUFACTURERS AND SUPPLIERS

A number of equipment manufacturers and suppliers have produced resources suitable for classroom use. Check with your local suppliers for resource listings.

DISTRIBUTOR DIRECTORY

The entries in the distributor directory are arranged alphabetically by code.

Code	Distributor/Address	Telephone/Fax
ACC	ACCESS Network 3720 - 76 Avenue Edmonton, AB T6B 2N9	(403) 440-7777 Fax: 440-8899 1-800-352-8293
AECD	Alberta Advanced Education and Career Development 10th Floor, CityCentre Building 10155 - 102 Street Edmonton, AB T5H 4L5	(403) 427-8765
AFRD	Alberta Agriculture Print Media Branch 7000 - 113 Street Edmonton, AB T6H 5T6	
AL	Alberta Labour 9940 - 106 Street Edmonton, AB T5K 2N2	(403) 427-8848
CIE	Center for Implementing Technology Education Department of Industry and Technology Ball State University Muncie, IN 47306	(317) 285-5659
LEC	The Lincoln Electric Company - Book Division 22801 St. Claire Ave. Cleveland, OH 44117-1199	Fax: (216) 486-1751
LRDC	Learning Resources Distributing Centre 12360 - 142 Street Edmonton, AB T5L 4X9	(403) 427-2767 Fax: 422-9750
MLC	Magic Lantern Communication Ltd. 38 - 775 Pacific Road Oakville, ON	(416) 827-1155 Fax: (416) 827-1154
NAIT	Northern Alberta Institute of Technology 11762 - 106 Street Edmonton, AB T5G 2K1	
WIC	Welding Institute of Canada 350 - 6815 - 8 Street NE Calgary, AB T2E 7H7	(403) 297-2631 Fax: (403) 297-2607

CAREER& TECHNOLOGY STUDIES

FABRICATION STUDIES

SAMPLE STUDENT LEARNING GUIDES

INTERIM 1995
(SEPTEMBER 1995 - SEPTEMBER 1997)

Introduction to
Construction and Fabrication (CFS101) J.1
Structural Design and Engineering (FAB201).....J.7
Material Testing (FAB301) J.15
Prefabrication Principles (FAB316) J.21

Alberta
EDUCATION

MAY 1995

CURRICULUM STANDARDS BRANCH

WHY TAKE THIS MODULE?

Ever since the beginning of the Stone Age, people have used technology to build needed artifacts and structures. This module will:

- ☑ Introduce you to common tools and materials
- ☑ Help you understand the basic techniques used in building and manufacturing
- ☑ Experience the satisfaction of constructing a lasting object.

WHAT DO YOU NEED TO KNOW BEFORE YOU START?

☑ You need to be:

- Able to read and follow directions
- Willing to work with others in a safe manner.

WHAT WILL YOU KNOW AND BE ABLE TO DO WHEN YOU FINISH?

- ☑ Describe how a technological system operates
- ☑ Compare the properties of common building materials
- ☑ Identify and describe the action of forces on a structure
- ☑ Recognize and use basic hand and power tools in a safe manner
- ☑ Construct a useful artifact or structure.

WHEN SHOULD YOUR WORK BE DONE?

- Review the work to be completed in this module with your teacher and allot your time so that you will be able to finish within the suggested time frame.

HOW WILL YOUR MARK FOR THIS MODULE BE DETERMINED?

	PERCENTAGE
☑ Technological Systems	5 - 10%
☑ Structural Engineering	5 - 10%
☑ Tool Identification and Use	10 - 15%
☑ Properties of Building Materials	10 - 15%
☑ Project Work	60 - 70%

WHICH RESOURCES MAY YOU USE?

- ☑ *Production Technology*
- ☑ *Technology Shaping Our World*
- ☑ *Design and Technology*, Nelson

ACTIVITIES/WORKSHEETS

1. Technological System

   1.1 People create technological systems to help solve problems. A system often includes these parts: input, process output and feedback. Select a simple household item and identify what:

   - input resources were required to make the product
   - processes were used to manufacture the product
   - were the intended and unintended outcomes
   - feedback the manufacturer might need to know to improve the product and the production process.

   1.2 Explain the difference between an open and a closed technological system.

2. Properties of Materials

   1.1 Designers and builders make choices about what materials they are going to use based on availability, cost and properties. Identify the cost and availability of five materials commonly used in building structures and products.

2.2 Properties of materials tell how a material can be expected to perform. Identify a simple test that can be used to determine:

- a mechanical property
- a material's reaction to heat
- how chemicals affect the material
- its optical qualities
- its electrical and magnetic properties.

3. Tool and Equipment Identification

As you work with technology, you will need to select the correct hand and power tools, and use these tools in a safe manner.

3.1 Identify and describe the use of two or more tools that can be used safely to:

- measure
- mark a surface
- cut through a material
- smooth a material
- form a material
- hold a material
- assemble a product using fastener
- apply a finish to a product.

4. Structural Engineering

There are many different types of structures and materials used in construction. All structures must be able to support their own mass and withstand additional loads or forces.

4.1 Describe the difference between and give an example of a static and a dynamic load.

4.2 Both static and dynamic loads create forces that act on structures. Explain the difference between stresses that are caused by compression and those caused by tension.

4.3 For a simple truss-like structure, identify components that are under compression and those that are under tension.

5. Construction and Fabrication Process

5.1 Complete the following activities in consultation with your teacher:

- Choose a simple artifact or structure that can be made from common building materials
- Locate a set of plans and a set of procedures that will help you build the product
- Identify and locate the appropriate materials and tools that are required to make the project.

5.2 The purpose of this activity is to design and build a matching set of structures. One structure will be built using Imperial measurements and the other using SI units of measurement. When you are finished constructing these structures you will be asked the following questions:

- Which system of measurement was easier to use?
- Which system achieved the greatest accuracy?
- What design features did you build into your plan to add strength to your structure?

Structures to consider constructing are a set of:

- book ends
- shelf brackets
- "c" clamps.

Evaluation

Your marks for these activities will be based on:

- accuracy of measurement
- how well the joints fit
- the proper use of fasteners
- the surface preparation
- the quality of finish.

WHY TAKE THIS MODULE?

Structures are an essential part of our natural and constructed world. In this module you will:

- ☑ Learn about many of the factors that designers and engineers need to consider when designing and building a structure
- ☑ Be able to apply these principles to your project designs.

WHAT DO YOU NEED TO KNOW BEFORE YOU START?

To be successful in this module you will need to have basic math skills and be familiar with fabrication tools, materials and processes.

WHAT WILL YOU KNOW AND BE ABLE TO DO WHEN YOU FINISH?

Upon completion of this module you will be able to:

- ☑ Identify the similarities between structures found in nature and those made using technology
- ☑ Apply structural principles to design problems
- ☑ Use materials in ways that maximize their physical properties.

WHEN SHOULD YOUR WORK BE DONE?

Preview the work to be completed in this module and allot your time accordingly.

HOW WILL YOUR MARK FOR THIS MODULE BE DETERMINED?

	PERCENTAGE
☑ Theory and related activities	20-25%
☑ Project Planning	20 - 25%
☑ Project Work	50 - 60%

WHICH RESOURCES MAY YOU USE?

- ☑ *The Art of Construction*, Chicago Review Press
- ☑ *Structure with Materials,* - Stanley Thornes (Publishers) Ltd.
- ☑ *Design and Technology*, Nelson

ACTIVITIES/WORKSHEETS

Investigation - Activity 1.0

1.1 Research Instructions: Using a separate sheet of paper, answer the following questions in statement form.

1. Define the term "structure".
2. List 5 natural or human-built structures within the current limits of your vision.
3. Classify these structures as being a frame, shell or non-rigid type structure or combination.
4. Select one of the objects and describe its structural elements.
5. Determine and list the function of each of the above elements.
6. Do any of the above elements provide more than one function? If so explain.
7. What materials are the 5 visible structures made of? Make a list of each.
8. What materials could be substituted for the materials that were used in the construction of these structures?
9. Make a list of these materials that are considered to be natural.
10. Make a list of these materials that are considered to be synthetic.
11. Look at the objects and determine which material(s) appear to be stronger, to wear or last longer.
12. Describe the forces that structures are designed to withstand.
13. Define the term "load"

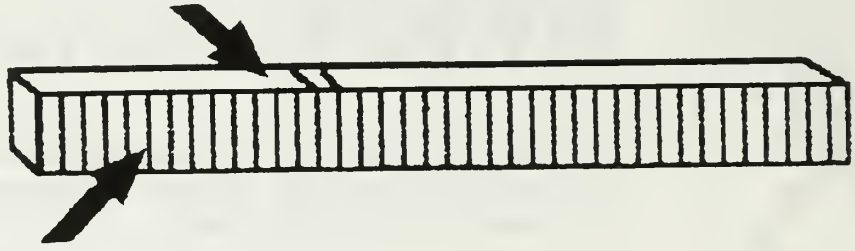
14. What is meant by safety margin?

Testing - Activity 2.0

Structural materials can all be tested for tensile strength, compressive strength, elasticity and ductility.

2.1 Tensile Testing

- Secure a piece of foam rubber approximately 30 cm (12") length and 5 cm (2") square.
- Using a ruler and felt marker, draw lines in 2.5 cm (1") intervals across the length of the rubber on 2 adjacent sides.



- Research the nature of a tensile load. Load the foam rubber with significant tensile stress and be sure to lock the foam into position securely for the remainder of this lab.
- On a separate sheet of paper sketch the effect of placing the foam rubber under tensile load.
- Measure the overall length of the foam rubber.
- Measure the width of the foam rubber across each of the lines and record the length at each.
- Examine the data and determine the relationship of the material and the loading.
- What general conclusion can you make from your experiment?
- List items currently in your vision which are under tensile load.

2.2 Compression Testing

Research the nature of a compressive load. Load the foam rubber with significant compressive stress and be sure to lock the foam into position securely for the remainder of this lab.

- On a separate sheet of paper sketch the effect of placing the foam rubber under the compressive load.
- Measure the overall length of the foam rubber
- Measure the width of the foam rubber across each of the lines and record the length of each.
- Examine the data and determine the relationship of the material and the loading.
- What general conclusion can you make from your experiment?
- List items currently in your vision which are under compressive load.

2.3 Testing for Elasticity

Research the nature of elasticity (deflection). To understand the nature of elasticity you should be able to set up and experiment using a ruler and strips of metal and plastic which are

suspended between two points, e.g., the backs of two chairs.

- Place the metal strip on top of the chair back. Position the ruler to measure the amount of deflection of the metal strip at its centre point. Press down at the centre point of the metal strip to deflect 1cm. Allow the metal strip to rebound (take the pressure off) and determine if the strip has returned to its original position.
- Continue to alternately measure and apply pressure, increasing 1 cm of deflection each time. Record the amount of deflection and rebound for each sequence forming a data chart.
- Determine the point at which you have exceeded the elastic capability of the material.
- Repeat the experiment using a strip of plastic.
- Which material has greater elasticity? Why?

2.4 Testing for Deflection

Research the nature of toughness (ductility). To understand the nature of toughness you should be able to set up and experiment using strips of metal and plastic which are repeatedly bent until failure results. This type of testing is called destructive testing because the structure is ultimately destroyed to determine its limits.

- Bend the strip of metal into a loop. While counting the cycles alternately move your hands apart, increasing the bend, and move them together, reducing the bend.
- As you are well aware the metal will fail sometime during the cycle. Note the number of cycles required to cause the material to fail.
- Repeat the experiment using a strip of plastic. Note the number of cycles required to cause the material to fail.
- Which material has greater toughness (ductility)? Why?

Structural Elements - Activity 3.0

3.1 Using a separate sheet of paper, answer the following questions in complete sentences.

1. Define the structural element called a beam
2. Why is a beam described as a linear element?
3. What is the load carrying function of a beam?
4. What devices within your vision are used as beams?
5. Describe the structural force exerted on a beam?
6. Define the structural element called a column.
7. Why is a column describe as a vertical element?
8. What is the load carrying function of a column?
9. What devices within your vision are used as columns?
10. Describe the structural force exerted on a column
11. Define a non-rigid structural element
12. How is a non-rigid structural element used?
13. What is the load carrying function of a non-rigid structural element?
14. What devices are used as non-rigid structural elements?
15. Describe the structural force exerted on a non-rigid structural element.
16. What would the function be of rigid and non-rigid materials connected to, or placed over, linear and vertical elements?
17. Give some examples of structures found in nature or in the world constructed using technology.

18. Define the structure commonly referred to as a truss.
19. Where are trusses used? (Give an example.)
20. Explain why trusses are rigid.
21. Describe the neutral axis of a beam.
22. How is a neutral axis calculated?
23. What is the effect of moving a load closer or further away from the neutral axis?

Structural Components - Activity 4.0

4.1 Structural components can all be tested for tensile strength, compressive strength, elasticity and toughness. You will now identify the action, reaction and result of these tests with the following lab.

- Secure a quantity of foam core, white glue and a razor knife from your teacher. On a cutting board cut 15, 2.5 cm (1") strips 30 cm (12") long.
- Glue the strips together to form 5, I beam structures.
- Place the I beam in a vertical position to form a column and secure it to a base.
- Place a suitable compressive load on the top of the beam forming a compressive load. Gradually increase the load to the point of failure.
- Determine the weight required (load) to cause failure.
- Determine the weight of the beam.
- Divide the value of the load by the weight of the beam to find the weight to strength ratio. (How many times its own weight will the beam support?)
- Prepare a base of wood for the next test. The edge of the base must be rounded to prevent the cutting of the bottom surface of the beam.
- Attach a beam horizontally to the base so that it extends 20 cm (8") beyond the base. Clamp the base to a table.
- Test the load carrying capability of the beam by suspending an unbreakable container of water or sand from the end of your beam.
- Slowly increase the amount of water until the weight causes the beam to fail.
- Examine the failed beam and determine the types of stress the test applied to the top and bottom surfaces of the beam.
- What are the physical characteristics of the structural failure?
- What is the strength to weight ratio for this test?

4.2 Structural shapes can be tested for shear, tension and twisting, Drawing on your previous experience devise and carry out a test for each. Write up your findings for each as you have for the previous lab. Be sure to:

- Examine the failed beam and determine the type of stress the test applied to the top and bottom surfaces of the beam.
- Determine the physical characteristics of the structural failure
- Calculate the strength to weight ratio for each test.

Building Structures - Activity 5.0

A model truss can be tested for loading. Drawing on your previous experience construct a truss

model out of wood strips, metal or foam core. Devise and carry out a test for your truss.

5.1 Write up your findings for your experiment as you have for the previous lab. Be sure to:

- Examine the failed beam and determine the type of stress the test applied to the top and bottom surfaces of the beam.
- Determine the physical characteristics of the structural failure.
- Calculate the strength to weight ratio for each test.

5.2 It is a fantastic day at the ski hill. Clear sky, great powder snow, but just a bit windy. In the middle of a run a great wind comes up, you become lost and wind up in the wilderness in the middle of a blinding ground blizzard. As night falls you must construct an emergency shelter from your skis, poles, nylon cord, and a sizable piece of plastic, all of which you have been carrying around all day.

- Using a separate sheet of paper answer the following questions in complete sentences.
- Sketch your tent design. It must be free standing because you don't have stakes to drive into the snow.
- Determine and indicate the stress exerted from the wind and the collecting snow.

- Anticipate the most likely point of failure. Refer directly to your knowledge and experience of the previous tests.

5.3 A model tent can be tested for loading. Drawing on your previous experience, construct a tent model out of wood strips, metal or foam core and plastic sheeting. Devise and carry out a test for on your shelter.

- Write up your findings for your experiment as you have for the previous lab.
- Be sure to:
    1. Examine the failed structure and determine the type of stress the test applied to the elements.
    2. Determine the physical characteristics of the structural failure
    3. Calculate the strength to weight ratio for the test.

Project Application - Activity 6.0

6.1 Select an existing structure and prepare a presentation showing how you would redesign the structure to show increased efficiency by:

- reducing weight while maintaining strength
- enhancing its durability and usefulness
- reducing material and construction costs.

WHY TAKE THIS MODULE?

To ensure that your design needs are met, testing is often carried out to determine which materials and processes best meet the desired outcomes. In this module you will:

- ☑ investigate methods of determining the properties of various structural materials
- ☑ test various materials and processes
- ☑ select the most appropriate materials and processes for a given application.

WHAT DO YOU NEED TO KNOW BEFORE YOU START?

To be successful in this module, you will need to have a basic understanding of material properties and be familiar with fabrication tools, materials and processes.

WHAT WILL YOU KNOW AND BE ABLE TO DO WHEN YOU FINISH?

Upon completion of this module you will be able to:

- ☑ identify typical materials testing techniques and apparatus
- ☑ construct a simple testing device and carry out comparative testing procedures
- ☑ determine how a given material might best be used.

WHEN SHOULD YOUR WORK BE DONE?

Preview the activities that are to be completed in this module and allot your time accordingly.

HOW WILL YOUR MARK FOR THIS MODULE BE DETERMINED?

	PERCENTAGE
☑ Theory and related activities	20 - 25%
☑ Test proposal	20 - 25%
☑ Material test and results	50 - 60%

WHICH RESOURCES MAY YOU USE?

Metallurgy Testing I & II - Ball State University
Metalwork - Technology and Practice, Glencoe
Welding Technology Fundamentals, Goodheart-Willcox

ACTIVITIES/WORKSHEETS

Types of Tests - Activity 1.0

1.1 Prepare a communication device that describes the nature of various types of static tests, dynamic tests, impact tests. Depict the anticipated results of these tests to the material being tested. Questions your poster should answer:

- What is a static test?
- How is a static test conducted?
- What are the nature of hazards involved in this type of testing?
- What is a dynamic test?
- How is a dynamic test conducted?
- What are the nature of the hazards involved in this type of testing?
- What is an impact test?
- How is an impact conducted?
- What are the nature of hazards involved in this type of testing?

Mechanical Tests - Activity 2.0

2.1 Prepare a communication device that depicts the nature of various types of mechanical tests. Sketch or trace the devices required to do each type of test. Depict the anticipated results of these tests to the material being tested. Your presentation should include:

- Examples of these tests:

  Compression
  Tension
  Impact
  Flex
  Plasticity
  Shear
  Fatigue

- a description of destructive and non-destructive testing
- an explanation of how material failure is recognized
- what hazards are anticipated for each test
- how operators and observers can be protected in the testing environment.

Planning - Activity 3.0

3.1 Prepare a testing proposal to present to your teacher for approval.

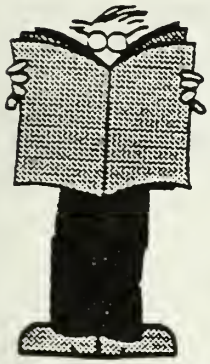
- List the type of testing you wish to do. Include a minimum of four of the listed test types
- Decide on the materials to be tested
- Prepare a plan of the testing equipment you will construct to complete the test. Be sure to determine the materials, processes and tools required to construct the testing device
- Plan a safe environment in which to conduct the test
- Present your teacher with the testing proposal for approval.

Testing - Activity 4.0

4.1 Refer to your plans and:

- establish safety controls
- prepare the materials to be tested
- prepare a sheet on which you will collect data and record observation. Record a brief description of each anticipated test result.
- conduct tests as planned
- observe testing results and collect data and samples
- compare testing results to anticipated results.

WHY TAKE THIS MODULE?



It is often more cost effective to build a product in pieces and have it assembled on site. By taking this module you will:

- ☑ gain skills in assessing and meeting customer needs
- ☑ discover the advantages of working with others to solve problems and using prefabrication principles
- ☑ experience the satisfaction of creating a complete component or building a complete structure.

WHAT DO YOU NEED TO KNOW BEFORE YOU START?

To be successful in this module, you should have a good understanding of fabrication processes, be able to communicate effectively and conduct yourself in an efficient and productive manner.

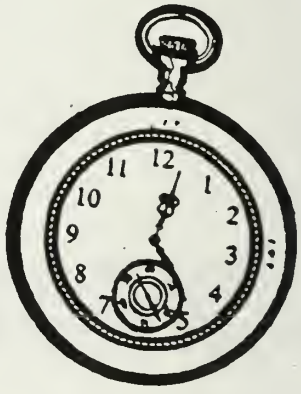
WHAT WILL YOU KNOW AND BE ABLE TO DO WHEN YOU FINISH?

Upon completion of this module you should be able to:

- ☑ assess client needs and skills
- ☑ effectively apply prefabrication principles to the design and construction of a component or a complete structure
- ☑ assess the efficiency of using prefabrication techniques over other production methods.

WHEN SHOULD YOUR WORK BE DONE?

Preview the work to be completed in this module and allot your time accordingly.



HOW WILL YOUR MARK FOR THIS MODULE BE DETERMINED?

	PERCENTAGE
☑ Theory and related activities	20-25%
☑ Project planning activities	20-25%
☑ Team assignments	50-60%

WHICH RESOURCES MAY YOU USE?

Metalwork: Technology and Practice, Glencoe
Modern Carpentry, Goodheart-Willcox
Principles & Practices of Heavy Construction, Prentice-Hall
Technology Shaping our World, Goodheart-Willcox

ACTIVITIES/WORKSHEETS

Complete the following activities

Principles of Prefabrication - Activity 1.0

There are numerous reason why it is more economical and time saving to construct a product or structure using prefabrication techniques.

1.1 Make a list of six or more structures that have been built using prefabrication processes, e.g., metal garden shed.
1.2 Examine one of the above examples and determine:
- what processes were carried out in a factory setting
- how were the prefabricated components packaged and delivered to the place where they were assembled
- what instructions were given to the customer/assembler
- what expectations did the customer have of the manufacturer and vice versa.

1.3 Identify the factors that often make it more economical and time efficient to produce a product using prefabrication techniques.

Meeting the Customer's Needs - Activity 2.0

Often the prefabrication is not involved with the final assembly of the product or structure.

2.1 What are some of the questions a prefabricator must have answered prior to making a design proposal?
2.2 Using a real or fiction product or structure identify:
- the components that can be prefabricated
- the work that is to be done on site
- the advantage to both the customer
- and manufacture to build a product/structure in the manner outlined.

Prefabrication Project Proposal - Activity 3.0

3.1 In keeping with a customer's/client's real needs individually or in a group prepare the following;
- overall statement of need, i.e., what is to be built, its purpose, design expectation and limitations
- a design drawing and specification
- materials list and cost
- list of components to prefabricated.

3.2 Prepare a list and provide designs for the needed jigs and fixtures.
3.3 Create a production flow chart, assembly drawing and written instructions
3.4 Identify what method/s the customer is expected to use in the completion phase of the construction, the expertise that will be needed and any additional materials or costs he or she will incure.

Prefabrication Project - Activity 4.0

Construct a product or structure that is best built using prefabrication principles.

4.1 Complete a task analysis and allocate your resources accordingly. If you are working with a team, pay attention to the strengths of each individual and divide the responsibilities to achieve the maximum results. Be sure to consult with your client as you work through the project. Each member of the group is expected to participate in the evaluation of each other's contribution to the project by completing the appropriate form. Each member will also be asked to evaluate the success of the product in meeting the design specifications.

Student:_____

Date:_____

Period:_____

Project:_____

GROUP EVALUATION FORM

The purpose of this form is to allow you to participate in the evaluation of how well the group functioned as a team in the planning and construction activities. Please select a numerical value, and indicate your rating in the response area provided.

Participation:

All(4), Most(3), Few(2), of your group members participated in the group activities related to the planning of your product. _____

All(4), Most(3), Few(2), of your group members participated in the group activities related to the construction of your product. _____

All(4), Most(3), Few(2), of your group members participated in the individually assigned activities related to the construction of your product. _____

Individual responsibilities:

All(4), Most(3), Few(2), selected their own individual responsibilities the completion of which the group depended. _____

All(4), Most(3), Few(2), were delegated duties by the group, to be completed. _____

All(4), Most(3), Few(2), completed their jobs accurately and on time. _____

All(4), Most(3), Few(2), attended class and participated in the production. _____

All(4), Most(3), Few(2), individuals cooperated with the other members of the group. _____

All(4), Most(3), Few(2), worked safely and with consideration for others. _____

Respond with a short written opinion:

What did you enjoy about working within a group?

What did you enjoy the least about working on a group project?

What will you do differently the next time you are involved in a group activity?

STUDENT PROJECT EVALUATION
(non-specific)

Student: Date: Period:
Module: Project:

Evaluate your project within the given criteria. Allocate points within the range specified. Submit this sheet with your project to your teacher for marking. Compare the marks allocated by your teacher and your evaluation. If you have any questions see your teacher.

Definitions:		
	Excellent	Far exceeds the basic requirements
	Good	Exceeds the basic requirement
	Fair	Meets the basic requirements
	Poor	Does not meet the basic requirements

Evaluation

Function: What was the intended function of your project? Rate how well it performs its intended function.

Excellent	Good	Fair	Poor	
15-10	9-7	6-4	3-1	_____

Form: What is the appearance of your product -- is it pleasing or clumsy? Will others find it attractive?

Excellent	Good	Fair	Poor	
15-10	9-7	6-4	3-1	_____

Durability: Can the product perform its role over a period of time? Will use destroy it? Will it last?

Excellent	Good	Fair	Poor	
15-10	9-7	6-4	3-1	_____

Safety: Are all cutting edges removed? Is it possible to remove or easily break off small pieces of material which could be swallowed, inhaled or cut the user?

Excellent	Good	Fair	Poor	
15-10	9-7	6-4	3-1	_____

Economy: Could excessive materials be removed which would not reduce the durability of the product?

Excellent	Good	Fair	Poor	
15-10	9-7	6-4	3-1	_____

Material selection: Were the proper materials selected for the product?

Excellent	Good	Fair	Poor	
15-10	9-7	6-4	3-1	_____

Finish: Is the finish appropriate and applied correctly for the materials used? Is the finish durable and does it enhance the appearance of the object?

Excellent	Good	Fair	Poor	
15-10	9-7	6-4	3-1	_____

Answer the following questions in paragraph form.

Process comments: What would you do differently if you were to repeat this project?

Equipment Summary: What tools (power and hand) did you use to produce this product? Which were new to you?

Product Innovation: How could you improve the next generation of this product?

Comments:

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